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Cer. 26321. d. 8/1863-67.



SCIENCE AND ART DEPARTMENT OF THE COMMITTEE OF COUNCIL ON EDUCATION, South Kensington.

DIRECTORY,

(Revised to September 1863.)

WITH

REGULATIONS

FOR

ESTABLISHING AND CONDUCTING

SCIENCE SCHOOLS & CLASSES.

THE RULES IN THE PRESENT EDITION SUPERSEDE THOSE IN ALL FORMER EDITIONS, BUT ARE ALWAYS SUBJECT TO REVISION.





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COMMITTEE OF COUNCIL ON EDUCATION.

SCIENCE AND ART DEPARTMENT.

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Deputy General Superintendent.—Philip Cunliffe Owen.
Science and Art Referees.—R. Redgrave, R.A.; J. C. Robinson, F.S.A.; Capt. Fowke, R.E.

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Clerk to Travelling Collection.—C. B. Worsnop. Clerk of Educational Collection, —David Craven. Official Photographer.—C. Thurston Thompson. Hon. Surgeon.—F. Seymour Haden, F.R.C.S. SUMMARY of the NATURE and Amount of Assistance afforded by the Science and Art Department to the Industrial Classes in procuring Instruction in Science.

[Important Alterations made since the last addition of the Directory are printed in Italics.]

- I. A sum of money is voted annually by Parliament for scientific instruction in the United Kingdom.
- II. This sum is administered by the Science and Art Department.
- III. The head of the Education Department of which the Science and Art Department is a branch is the Lord President of the Council, assisted by a member of the Privy Council, who is called the Vice-President of the Committee on Education, and who acts under the direction of the Lord President, and for him in his absence. (Order in Council, 25th February 1856, Act 19 & 20 Vict. c. 116.)
- IV. The object of the grant is to promote instruction in Science especially among the industrial classes,* by affording a limited and partial aid or stimulus towards the founding and maintenance of Science schools and classes,†
- V. The payment of fees by the students Fees by can be looked upon as the only solid and Students. sufficient basis on which a self-supporting system can be established and supported. Though my Lords do not consider it necessary at present to lay down any rules making the payment of fees an absolute condition of the grants on account of Science

^{*} Direct payments are made to teachers only on behalf of adult artisans, or the children of artisans, or the children of persons who are not assessed to the income tax, or who do not possess an income of 100l. a year. (See § xiii.)

[†] The amount is liable to be decreased and eventually withdrawn. Payments to teachers therefore must not be looked upon as perpetual, or in any conferring on the teacher a claim to any payments beyond those offered for each current year.

instruction, yet as the payments from the State must be expected to diminish, and as aid on account of those persons who do nothing for themselves cannot be justified, Committees of schools and classes, and Teachers, are strongly urged (should it at present not be the practice) at once to impose as high a scale of fees as they consider can be raised not only on middle class students but also on artisans.

VI. The following are the Sciences towards instruction in which aid is given:—

GROUP I.

Subject 1, Practical Plane and Descriptive Geometry.

2, Mechanical and Machine Drawing.

3, Building Construction or Naval
Architecture.

GROUP II.

1, Theoretical Mechanics.

2, Applied Mechanics.

GROUP III.

1, Acoustics, Light, and Heat.

2, Magnetism and Electricity.

GROUP IV.

1, Inorganic Chemistry.

2, Organic Chemistry.

GROUP V.

1, Geology.

,,

,,

2, Mineralogy.

GROUP VI.

1, Animal Physiology.

2, Zoology.

GROUP VII.

- 1, Vegetable Physiology and Economic Botany.
- 2, Systematic Botany.

GROUP VIII.

" 1, Mining.

,, 2, Metallurgy.

VII. The assistance granted by the Science and Art Department is in the form of—

1. Payments on results to certificated teachers. (See § xv., xviii., xix., xx., and xxi.)

2. Grants towards the purchase of apparatus, &c. (See § xxiii.)

3. Public examinations in which Queen's Medals, Honorary Certificates, and Prizes are awarded, held at all places complying with certain conditions. (See § xi., xii., xiv., xv., xvi., and xvii.) On the results of these examinations the payment on results is made to the teachers. (See § xv., xviii, xix., and xx.)

VIII. Examinations for certificates to Examinations teach any of the before-mentioned sciences Certificates. are held annually, commencing in the first week in November, at South Kensington. Examinations will also be held in Dublin and Edinburgh if five candidates register themselves for examination in Ireland and in Scotland. Any person whatever may attend this examination by sending in his name to the Secretary of the Science and Art Department, before the 15th October, stating the subject or subjects in which he wishes to be examined. Certificates of three grades are given in each group and each subject. These certificates are only considered as simple records of the results of examination in the various sciences before mentioned, entitling the teacher to earn payments by successful teaching in the subjects for which he is certificated.

2. IX. Suitable premises, with firing, light-school Preing, &c., must be found and maintained at the cost of the locality where the school or class is held. If at any time the funds do not cover these requisite local expenses, it must be inferred that there is no such demand as the Government is justified in aiding, for instruction in the locality; and the assistance of the Department will be withdrawn.

X. A Local Committee of not less Local Committee.

must be formed in connexion with every Science Class, who will carry out the instructions contained in Appendix. See Science Directory, pages 15 to 18.

Examination XI. The Science and Art Departof Classes ment holds, through the agency of each under Cer-Local Committee, in May of each year, Teachers. a public examination of all Science schools and classes in any locality throughout the United Kingdom which complies with the requisite conditions. On the results of this examination the payments are made to certificated teachers. cation for it must be made to the Secretary of the Science and Art Department before the end of March in each year, stating the number of persons and the subject or subjects in which they are to be examined. All registered Students of Science Classes under certificated teachers (except Science certificated teachers) are eligible to receive Queen's prizes and Queen's medals under the conditions hereafter mentioned. (See § xv., xvi., and xvii.)

Examination XII. A school or class taught by of other a teacher not holding a certificate, may, Classes. by applying to the Secretary of the Science and Art Department, be examined at the same time and in the same manner as the classes under certificated teachers; provided that a Local Committee be formed which complies with the requisite conditions. (See Appendix, pages 15 to 18, Science Form, No. 88 a.) If the class be for artisans [the pupils are eligible to receive Queen's Prizes and Queen's Medals under the same condition as the pupils of certificated teachers. Should it however be for the middle classes the pupils are not eligible for prizes and medals, but receive certificates of merit instead.

Places of Examination. XIII. If two or more classes in the same town, or within a reasonable distance of one another, apply for the examination of the

Science and Art Department, a general examination committee must be formed by the amalgamation of the several Committees to carry out the examinations at some common centre, such as the town hall or other public building. It is only when the classes consist of 100 or more candidates that such amalgamation of the committee will not be insisted on at present.

XIV. Any persons whatever, whether Examination of other taught by the certificated teacher or not, Students. may present themselves at the Local Committee's examination on registering their names in time for the Local Committee to comply with the instructions, and paying a registration fee of not more than 2s. 6d. each. Arrangements must therefore be made by the Local Committee, or the general examination committee, as the case may be, to enable other candidates, besides the students in the class for which the Committee act, to present themselves at this examination. The registration fee of 2s. 6d., which such candidates may be required to pay, is to reimburse the Committee for any extra expenses incurred by such attendance, and may at their option be remitted. These candidates, if artisans, are eligible to receive Queen's prizes and certificates of merit (see § xvi. and xviii.); if registered students in artisan classes, they are eligible to receive Queen's medals, Queen's prizes, and certificates of merit under the conditions mentioned in § xvi. and xvii.; and if middle class students to receive certificates of merit.

XV. The results of the May examination are classified under the following
heads:—(1) first class, (2) second class, (3) third
class, (4) honourable mention, (5) pass, and (6)
failed. The names of the successful candidates,
those under the first five heads, are published. The
standard of attainment required may be raised from
year to year. For the Pass it is only such as will
justify the Examiner in reporting that the instruction

has been sound, and that the students have benefited by it. Those who have attained a higher degree of proficiency are classed as honourable mention, or as 3rd, 2nd, or 1st class, according to their merit.

Queen's Prizes.

Queen's prizes consisting of books chosen by the candidates from lists furnished for that purpose. These are unlimited in number, except that a student who has once received a 1st class Queen's prize cannot receive a prize in the same subject again. If such student should be again successful, his name will simply be recorded in the published list. To the 2nd and 3rd class certificates of Merit.

Certificates of merit recording the result of the examination are given.

Queen's XVII. The Queen's medals are—one gold in each group, one silver, and two bronze in each subject for competition throughout the United Kingdom.

Only registered students of schools and classes under Local Committees (see § xi. and xii.) can obtain medals. They cannot be taken by middle class students who are more than 17 years of age. Students who but for this restriction would have taken the medal, will receive an honorary certificate instead. Should a student take more than one gold, silver, or bronze medal, he will receive books instead of a second medal.

Payments to Teachers. XVIII. The payments to the certificated teacher are as follows:—He receives 1l. for every student of the industrial classes who has received 40 lessons from him in the subject in which he is certificated, and passes in such subject of scientific instruction; 2l. for every one who is honourably mentioned; 3l., 4l., or 5l. for every one who takes a 3rd, 2nd, or 1st class. These students must have received 40 lessons at least from the teacher since the last examination at which payment

was claimed on their account. The 40 lessons need not necessarily be all given in one year, but may extend over a longer period. 5l. is the maximum that can ever be claimed on account of the instruction of any one pupil in a subject, and this, only, subject to the reductions entailed by § xix. and xx. That is to say, for a pupil taking a 1st class for whom at a previous examination the teacher received 3l. for a 3rd class, he can only claim 2l. If the same pupil had previously taken a 2nd class the teacher could only claim 1l. on his account, and so on.

XIX. If a student be successful at the examination in more than one subject, the teacher can only claim half of the above payments in respect of such further subject in which he is successful.

XX. Payments are only made on the foregoing scale when they amount to not more than 60l. When on this scale they would amount to more than 60l. the excess up to 40l. is diminished by one quarter, the excess above 40l. by one half. Thus payments which on the above scale would be 100l. and 150l. will be reduced to 90l. and 115l. respectively.*

XXI. The claim of a master for the payments under these several heads is made on Science Form No. 51, which will be sent on application. The voucher must be signed by the secretary and two members of the committee of the science class or school; or by at least three of the committee. (See Appendix, page 19.)

XXII. A school register according to School an approved form must be kept, which will be examined by the Inspector on his visit, and must be sent to the Department when required, and approved before any payment can be made.

^{*} Thus, 100, that is 60+40, is reduced to $60+40-\frac{1}{4}$ of 40 = 60+30=90. 150, that is, 60+40+50 is reduced to 60+30+25=115.

AXIII. A grant towards the purchase of apparatus, diagrams, &c., of 50 per cent. on the cost of them, is made to science schools and classes in Mechanics' and similar institutions where the teacher is certificated, and to the extent of 51. to other poor schools and classes. A requisition must in these cases be made on Science Form, No. 49.

Travelling Expenses of Teachers. XXIV. The travelling expenses (second-class railway fare, and 10s. per diem personal allowance) of a candidate in attending the November examination are paid if he be successful in taking a certificate or in improving the grade of one he has already taken, provided the candidate is bonâ fide engaged in tuition, or is preparing for tuition.

Instruction in an Elementary School.

XXV. All payments to certificated teachers on account of Science teaching are made by the Science and Art Department, and are only made in respect of a school in connexion with the Science and Art Department. They do not apply to any instruction in Science that may be given during the three attendances of an Elementary School receiving aid from the Education Department, Whitehall.

Use of XXVI. These grants are only made Elementary while the teacher is giving instruction School Premises. in a day or evening school or class for the industrial classes (adults or boys), approved by the Science and Art Department, and open at any time to the visit and inspection of its officers. The Managers of an Elementary School under the inspection of the Education Department can permit such part or parts of their premises to be used for Science teaching as shall not interfere in any way with the three attendances of the Elementary School.

XXVII. The certificated teacher of Master with an elementary school who has pupil-teachers to teach cannot receive payments on account of Science teaching, even if holding a Science certificate.

XXVIII. But certificated teachers Masters without of elementary schools receiving aid from the Educational Department who have not pupilteachers to teach have their time out of schoolhours at their own disposal, so far as official regulations are concerned, and may if further certificated in Science give scientific instruction under the Science and Art Department.

APPENDIX

EXHIBITIONS, SCHOLARSHIPS, AND PRIZES, AT, THE ROYAL SCHOOL OF MINES.

At the May 1864 examination the following Royal Exhibitions and Free Admissions to the Royal School of Mines will be open for competition independent of the prizes, &c. offered by the Science and Art Department.

ROYAL EXHIBITIONS.

1. Two Royal Exhibitions of the value of 501. per annum entitling the holders to free admissions to all the lectures, and the Chemical and Metallurgical Laboratories at the Royal School of Mines, to be held from year to year for three years on the condition that the holder attends the lectures and passes the examinations required for the associateship of the School.

The competition for the Royal Exhibitions will be determined by affixing the following values to the several results of the May examination, viz.:—

To a 1st grade Queen	n's Prize	e, in s	ny subjec	et -	- 91	narks.
To a 2nd "	99		,,	•	- 7	. 33
To a 3rd " To an honourable m	20.		29	•	- 5	30
	ention		22	•	- 3	**
To a pass	-	-	,,	•	- 1	**
and in addition—						
For a gold medal	-	-	29	-	- 18	**
For a silver medal	-	-	>>	•	- 7	33
For a bronze medal	•	-	• ,,	-	- 5	39
N.B.—Science Certificated T	eachers!	may	compete	for the	Royal E	xhibitions.

FREE ADMISSIONS.

2. Free admissions to the lectures at the School of Mines.

 $\boldsymbol{\Lambda}$ free admission is granted to any person who takes a gold medal in the May examination,

There are, in addition, the following Scholarships attached to the School-

HIS ROYAL HIGHNESS THE DUKE OF CORNWALL'S SCHOLARSHIPS.

His Royal Highness the Prince of Wales, as Duke of Cornwall, has granted two scholarships of 30*l*. each. One becomes vacant every year, and will be competed for by those students only who have passed the examinations of the first two years of the curriculum required for associates. It is held for two years by the successful competitor.

ROYAL SCHOLARSHIPS.

Two scholarships of 151. each are given to the students who shall stand highest on the list of those who have passed their examinations for the first year—and a scholarship of 251. to that pupil, not being the Duke of Cornwall's scholar, who passes the best examinations after the end of the second year. These scholarships will be granted to those students only who have obtained first-class places in the examinations of their year, or in those of at least two of the Professors in the case of such students as take the two first years in one.

For further particulars see prospectus of the "Royal School of Mines," to be had on application at the Museum in Jermyn Street.

SCIENCE FORM, No. 88.

LOCAL COMMITTEES FOR SCIENCE SCHOOLS AND CLASSES.

- 1. A Local Committee of not less than five well-known responsible persons must be formed in connexion with every Science class, in order to comply with the necessary requirements of the Science and Art Department, and to carry out various arrangements on its behalf necessary for testing the efficiency of the science instruction, on the proof of which alone the aid of the Department is given.
- 2. The gentlemen proposed to act on this Committee are to fill in the form on the next page, stating their willingness to carry out the necessary arrangements for examinations, &c., and giving the address and occupation of each member.
- 3. The relation of the Committee to the teacher of a Science school or class will vary much according to the varying circumstances of different localities. In some places where the demand for science instruction is great, and there is an energetic local teacher to take advantage of it, the chief duty of the Local Committee may be to give the teacher the necessary vouchers for obtaining his payments. While in other places, where those who take an interest in and wish to further science instruction may, with that object, subscribe to and establish scientific classes either in connexion with an existing institution or not, and may engage a teacher certificated in science to instruct the classes, the teacher must. to a great extent, be the paid officer of the Committee. With these local arrangements the Science and Art Department does not interfere, but leaves them to the locality to settle. The local circumstances will determine whether, as in the first case, the master receiving the whole of the fees for instruction should provide at his risk the room for instruction, with the necessary firing, lighting, &c., or what, as in the second case, should be the proportion of the fees deducted on this account by the Committee.
- 4. The Science and Art Department requires that the Local Committee shall
 - a. Be responsible for the safe custody of all apparatus towards the purchase of which the Department has paid 50 per cent.

- b. That they shall provide a room or rooms of sufficient size to carry out the annual examination according to the detailed regulations under that head. This examination is of all persons who wish to present themselves, and not only of those taught by the certificated teacher; but those persons who are not taught by the certificated teacher must send in their names before the 1st March, and may be required to pay a registration fee of 2s. 6d. for the whole examination.
- c. That a school register, showing the attendance, number of lessons, payment of fees, &c., on an approved form, be kept properly filled up, and sent to the Science and Art Department when required.
- d. That they shall send in to the Secretary of the Science and Art Department the list of students to be examined, before the end of March, specifying the subjects in which they are to be examined. That they shall be responsible for conducting and superintending the examination: giving out the examination papers which will be sent for that purpose: seeing them worked fairly and certifying to the same, not less than three of the Committee being always present: and sending the worked papers, under seal, by the day's post to the Secretary of the Science and Art Department.
- e. That they shall certify, firstly, that those students on whose examination the teacher bases his claim to payments on results, are artizans or operatives, or their children, or can claim as such (see Science Form, No. 51); and, secondly, that they have received 40 lessons at least from the teacher in the year or since the last examination, on their passing at which payment was claimed on their account.
- 5. The Science school or class must be at all times, open to the visit and inspection of the officers of the Science and Art Department as a condition to the grant of aid from it; if at any time it is found that the apparatus, &c., towards the purchase of which a grant has been made is not properly taken care of, or that a proper room with firing, lighting, &c., is not provided for the class, the aid of the Department will be withdrawn.

Form of Application to act as a Committee for a Science School or Class. We the undersigned,

[1. The Committee shall be composed entirely of well-known responsible persons of position who are quite independent of the school or class, and who have no such personal interest in it as can lay them open to the slightest suspicion of partiality; and of course no member should be connected with the Teacher, have any pupils for examination, or be a pupil himself.

It is very desirable that as many persons as possible in recognized positions of public responsibility in the district, such as Magistrates, Municipal Authorities (Mayor, Aldermen, or Town Councillors), Head of Educational Establishments (Trustees of Grammar Schools, Managers of National Schools), Clergymen, &c., should be on the Committee.
 It is absolutely necessary that at least two such responsible persons should

agree to act.
4. The Committee must consist of a Chairman, Secretary, and at least three other Members.

Members.

5. The Chairman must be a Magistrate, Mayor, Boroughreeve, Provost, or Alderman, or other public officer of recognized position, Trustee of Grammar School, or Clergyman of the Established Church in parochial employment.

6. The Chairman of the Committee will inform My Lords as to the constitution of the Committee being in accordance with these requirements.

7. The Secretary of the Committee of the Science School or Class, as being the medium of communication, will carry on all correspondence with the Science and Art Department, and is held responsible for making out and sending all returns required, for the receipt and distribution of the examination papers.

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the transmission of the worked papers, &c., at the proper times according to the regulations; and in consequence of the necessary demands on his time and trouble My Lords have sanctioned, provisionally, the payment to him of the following fees:—32. for the duties connected with any Science school or class consisting of 5 or more pupils which is examined, and 11. in a ldition for each further day's examination held. The Secretary must be a member of the Committee; the requirements in s. 1 apply equally to him.

8. This form is to be filled in and returned to the Department annually before the 18th December, except in the case of new schools or classes, when it should be made as soon as they are formed.]

propose	to	act	88	the	Local	Committee	for	the	Science	Class	held	at
---------	----	-----	----	-----	-------	-----------	-----	-----	---------	-------	------	----

and taught by			
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We undertake for the year at least, and further till another Committee satisfactory to the Science and Art Department has been appointed.

- 1. To be responsible for the safe custody of all the Apparatus, Diagrams, &c., towards the purchase of which the Department has in any way contributed.
- 2. That three or more of our number will be ready at the appointed time to be present at, and superintend, the examinations of the Science Class according to the instructions of the Science and Art Department, and give the teacher the necessary vouchers.
- 3. That a room or rooms shall be provided for the due carrying out of such examination, according to the rules of the Department, providing sufficient space for the examination, not only of all persons taught by the certificated teacher, but of all others who may wish to attend the examination.

(A fee of not more than 2s. 6d. may be charged on each applicant for examination who is not a student in the class, to reimburse the Committee in any extra expenses they may be put to in providing a room).

4. That the School or Class shall be open at any time to the visit and inspection of the Officers of the Science and Art Department.

SIGNATURE.	Address.	OCCUPATION,
Chairman.		
Secretary.		

I certify that this Committee complies with the requirements of the rules 1, 2, 3, 4, and 5.

Chairman.

The Secretary, Science and Art Department.

This form may be had on application to the Secretary, Science and Art Department, South Kensington.

SCIENCE FORM, No. 88 a.

South Kensington, August 1863

11 11 1

LOCAL COMMITTEES	FOR	SCIENC	CE SCI	RIOOLS	AND	CLA	SSES
NOT RECEIVING	\mathbf{AID}	FROM	\mathbf{BUT}	EXAM	INED	\mathbf{BY}	THE
SCIENCE AND AR	T DE	PARTM	ENT.				

-This Form is a modification of the previous, No. 88., and may be had on application to the Secretary, Science and Art Department, South Kensington.

FORM No. 368.

The following form, which may be had on application to the Secretary, Science and Art Department, is filled up in italics as an example of the manner in which it should be done.

AN ACCOUNT OF TRAVELLING AND PERSONAL EXPENSES DISBURSED AND CHARGED

BY
Thomas Jones,
From the end January 1860, to the 4th January 1860.

I hereby certify that the travelling expenses detailed below have been actually disbursed by me in travelling in the execution of my public duties, that the personal expenses are charged according to the regulations, and that the total sum of \pounds is due to me for the services stated.

Thomas Jones.

[Name and title of officer to be specified.]

Teacher of Chemistry in———School of Manchester.

Date upon which the services were Performed.	In this column must be stated the service on account of which the journeys were performed, and the details of the expenses incurred.	TOTAL AMOUNT
1860. and January. ord January. 4th January.	To attend examination in Chemistry held at South Kensington on srd January 1860. Railway fare from Manchester to London (snd Class) Omnibus fare to and from Euston Square and South Kensington Railway fare from London to Manchester - 4 4 0 2 days personal allowance at 102.	8 9 0 4 0 0 8 9 0
NOTE.—Should	l the successful candidate live in London or near enough t ly to be allowed ss. per diem besides his travelling expenses.	o get hom
Examined at	nd approved,	
	Secretary.	
Received this	day of 18 , the sum of	pound
shillir	ngs andpence in payment of the above amou	nt.
£		



SCIENCE FORM No. 51.

		Science Teacher in						
School or Institution at			for payme	ent.				
SIR, BEING certificated in ing claim is made, I required for the year ended named below, may be partited of Management authorized have been duly	est tha 186 id to m that th	t the sum of £, according to e; and I appearance conditions	being the regulations and certificates	ng the allowance , on the students from the Com-				
On behalf of the Comm	uittee of	Management	of this School	, We do hereby				
(1). That Mrdevolving upon his	the foll	Science Teach _day of owing Student examination a	s at least 40 t which payme	Lessons during ent was claimed eratives * in the				
 -	_	•		bers of Committee.				
N.B.—These must be arrang	ed alpha		ERATIVE STUDE n subject, the nan list of names.					
Surname. Christian name in full. A	ge last rthday.	Trade, or father's trade. (State which is given).	Position at the late Examination.	Highest position in same Subject at any previous Examination.				
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&c. &c.								

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^{*} Should the Teacher have instructed any Students who may fairly be considered to belong to the artisan or operative class, but whose wages are paid at longer intervals than a week, the claims on their account must be made by the Committee of the School on the form on page 18, when they will be considered on their merits.

On behalf of the Coto recommend that the claim the allowances of taken as belonging (1). That he has gissince the last account. (2). That they, orfathers are not (3). That the followapplication are	he Teacher, on the follo to the oper even them for examinatio —in case the assessed to wing parti	wing students, ative classes. orty (40) lesson at which posses are not earnithe income tax	whom we con We certify:— ss at least duri syment was cl	be allowed to sider may fairly ing the year, or laimed on their ivelihood—their
Names of Pas N.B.—These must be are	ranged alpha		subject, the na	
Surname. Christian name in full.	Age last Birthday.	Trade, or father's trade. (State which is given).	Position at the late Examination.	Highest position in same subject at any previous Examination.
1				
•	Departmen	re of Master t.	m, Sir, Your obedier	•
Examined and found . Approved	correct to t	day	y of	186

CONDITIONS UNDER WHICH APPARATUS, INSTRUMENTS, BOOKS, &c. MAY BE OBTAINED BY SCIENCE SCHOOLS OR CLASSES (TAUGHT BY A TEACHER CERTIFICATED IN SCIENCE),* IN PUBLIC SCHOOLS, MECHANICS' INSTITUTIONS, &c.

1. The Lords of the Committee of Council on Education, having had under their consideration several applications from the managers and masters of Mechanics' and other Institutions, for grants to be made to them of Apparatus and Illustrations, recommended by the Science and Art Department for teaching science, think it necessary to adopt some general principle which shall regulate the decisions of the Committee in reference to such applications.

Their Lordships have already fully recognized the great importance of practical science to all classes of the community, in all relations of life. They are, therefore, desirous that the Science and Art Department should assist, as far as possible, in promoting the distribution of diagrams and apparatus as the means of accomplishing this object; but as the indiscriminate gift of these aids for instruction to all applicants might lead to abuse, it is necessary to require some guarantee that they will be duly appreciated, which the mere request to have them does not imply.

The principle which governs the whole proceedings of the Department in all its branches is to afford partial aid, and to encourage, but not supersede public exertions in promoting education in science. They have, therefore, resolved that the Department shall have the power to assist schools and classes taught by a certificated teacher in Mechanics' and other institutions in purchasing diagrams and apparatus for teaching science at a reduction of 50 per cent. on the net cost.

Lists of the scientific diagrams and apparatus prepared by the Department, according to conditions of the following Minute, may be obtained of the Secretary of the Science and Art Department, South Kensington, London, W. It should be distinctly understood that the aid of the Department in purchasing these articles at a reduced price, if above 10*l*. in value, can be granted only to public schools and institutions when taught by a certificated teacher.

Minute of the 23rd March 1860.

"The Lords of the Committee of Council on Education desire to afford the greatest facilities to teachers of science and navigation schools in obtaining the best instruments, apparatus, &c., for giving instruction in science and navigation, towards the purchase of which the Science and Art Department is authorized to pay 50 per cent. of cost; and they consider that the fullest opportunities should be given to manufacturers in all parts of the Kingdom for supplying such apparatus, &c. At the same time it is necessary that the Science and Art Department should have some guarantee that the apparatus and instruments are of good quality,

Apparatus not exceeding 10L in value may be obtained by poor Schools and Mechanics' Institutes, not taught by a certificated teacher, under the same conditional that is, the Department will aid them to the extent of 5L.

and moderate in price. My Lords have therefore laid down the following rules and conditions:—

- "1. Samples of all articles on the manufacturer's list are to be sent to the Educational Collection, South Kensington Museum, for exhibition, where they will be arranged separately, according to the science for which they are intended, so as to afford teachers and others facility in inspecting them and making a choice.
- "2. The manufacturer is to supply priced catalogues of such articles printed in demy 8vo., in order that the various catalogues may be bound up together and supplied when asked for.
- "3. The manufacturer is to guarantee that the articles exhibited are fair samples of those specified in the priced catalogue, and he must engage to take back any article supplied to schools which may be inferior to the standard."

Manufacturers willing to comply with these conditions are to make a statement to that effect, and to send lists of apparatus, instruments, books, &c. in the following sciences:—1. Practical plane and descriptive geometry, mechanical and machine drawing, and building construction; 2. Physics (mechanical and experimental); 3. Chemistry; 4. Geology and mineralogy; 5. Natural history (zoology and botany, vegetable and animal physiology); 6. Navigation and nautical astronomy, and physical geography. If these lists and prices are such as can be approved of, the manufacturer will be informed, and as soon as possible on his fulfilling the conditions, his list will be inserted in the catalogue. The catalogue will undergo a revision at least once a year, when manufacturers may send any improved forms of apparatus, &c.

The selection of the manufacturer will lie wholly with the Committee of the school. On their demand being sanctioned, the manufacturer will receive instructions to supply the articles upon his receiving the 50 per cent. due from the school.

On obtaining a receipt from the Committee of the school (which is included in the form of the requisition) that the articles have been received, the remaining 50 per cent. will be paid quarterly to the manufacturer by the Department.

2. Payments, including charge for packing, must be made in advance to the agents on receipt of the invoice. The goods to be sent at the risk of the purchaser.

All communications to be addressed to the Secretary of the Science and Art Department, South Kensington, London, W.

By Order of the Committee of Council on Education.

N.B.—Apparatus grants will in future be rigorously confined to articles of a permanent and non-destructible nature; hence no aid will be afforded in the purchase of breakable articles, such as glass retorts; test tubes, &c., or, indeed, generally in the purchase of articles to be used by the student as distinguished from those of a permanent and illustrative character which are required by the teacher in giving instruction in science.

SCIENCE FORM, No. 49. FORM of REQUISITION which may be had on application to the Secretary, Science and Art Department. The following Requisition for Aid in purchasing apparatus, &c., after being filled up as required, is to be transmitted to "The Secretary of the Science and Art Department, South Kensington, London. W." N.B.—It is to be understood that the Department has a lien on the apparatus, &c., furnished to public institutions to the amount of the public aid given in supplying them; they cannot therefore be sold. 1. REQUISITION for AID in purchasing apparatus, &c. , &c. No. 1 appli-- School or Institution (*) cation to be For the use offilled in by In the City or Town of (*)-Requision-. In the County ofist, with full par-ticulars. Male Female Having (a) Pupils (Artizans or Operatives) of the Science Class. (a) Erase the words that do not apply. (a) Scholars or Members of Poor School or Meand chanics Institute. Total. I request the aid of the Department in obtaining from M the spparatus, &c., named in the opposite page, and I undertake that the same shall be kept and used in the above-mentioned (*) school or institution for which they have been demanded. The address to which the parcel is to be sent is as follows:--To be forwarded to per-Signature of Requisitionist. Dated this day of Agent, No. 2 to be filled in by 2. Requisition sent to M. day of - 186 the Departand authority given for the supply of Articles to the extent ment. of Net Sum , together with will be paid by the Department, and £ the cost of packing, by the school or institution, previous to the goods being applied. Assistant Secretary. 3. Invoice of articles sent to Requisitionist as under, this day No. 8 to be filled in by Articles (Retail Price) agent on Deduct as above.transmis sion of the Aid by Department invoice. £ Add, for packing Total to be paid by Requisitionist received from schools this 4. Amount & day of Nos. 4 and 5 186 to be filled in by agent. Agent. 5. Examples forwarded as directed above, together with Requisition, this-188. day of 6. Examples as per invoice received, and *Requisition returned to Agent. this-No. 6 to be

- 186

day of-

Requisitionist.

filled in by

Requisition-

^{*} It is requested this paper may be returned to the Agent in an entire state after the examples have been received.

SCIENCE FORM, No. 91.

Rules for the Conduct of Science Examinations.

1. The following rules must be hung up in the examination room for the information of the candidates one week before the examination. They must also be read aloud before the Committee and the candidates on each night immediately before the examination begins.

2. A room or rooms of such a size that, when seated, the candidates shall be at least five feet apart, from centre to centre, must be provided

for the examination.

3. All Diagrams, &c. must be removed from the walls of the examination room.

4. Ink and blotting paper must be provided by the Committee for

the use of candidates.

5. If one room is used three of the Committee must be present during the whole of the examination, if more than one room then two of the Committee per room,* who must carefully watch the whole examination and see that candidates use no unfair means either by assisting one another or using books or notes.

6. The examination papers will be forwarded, under cover, to the Secretary of the Committee so as to be received by him on the morning

of the day fixed for the examination.

7. The candidates must be seated at their places at 6.50 p.m. After this time no candidate shall be admitted except under very exceptional circumstances, and that only by express permission of the Committee. No candidate may on any account be admitted after 7.30 p.m.

8. The examination papers must be opened in the examination room in the presence of the Committee, at 6.55 p.m. No examination paper

may be taken from the room till after 8 p.m.

9. When the candidates are seated and the papers given out, the Committee will see that the candidates commence by filling in their names, &c., where directed. All the worked papers must be collected at 10 p.m., initialed, put under cover, and sealed in the presence of the members of the Committee; and forwarded by the first post to the Secretary of the Science and Art Department.

10. Candidates must on no account bring anything with them into the examination room,† except pens and pencils. No scribbling paper or anything of that nature must be allowed. Arrangements must be made by which all books, note-books, &c., can be given up and left at the

door.

11. Candidates must not on any pretence whatever speak to one another after the papers have been given out. If a candidate should require to ask a question, he will hold up his hand, when a member of the Committee will attend to him, but no question on the meaning of any portion of the examination paper must be asked or answered.

12. It may be of service to the Committee that the teacher of the class should attend before the examination to assist in getting the candidates into their places, &c.; but from the peculiar character of the examination it is so very necessary that not the slightest opportunity for misconstruction should exist that it is evident that he should not be in

When there are not more than three candidates it will not be necessary for more
than two members of the Committee to be present at the examination,
 † Except in the drawing examination, when drawing instruments are allowed.

the room after the examination papers are opened. Information of his having remained in the room after this will at once lead to the examination being declared null.

NOTE.—Should the teacher of the class wish to compete at this examination for the Royal Exhibitions of the Royal School of Mines, he must apply especially to the Committee for permission, so that they may arrange to have a table for him close to their own seats, and not with the other candidates.

13. The examination papers being given out no candidate must be allowed to return after having once left the room.* On a candidate

leaving the room his papers must be taken up.

14. At 10 p.m., precisely, all the candidates must cease working, and members of the Committee will collect their worked papers from them at their places. It will therefore be advisable to warn them ten minutes before the time. The papers will be initialed, by the Committee as directed, as they are received from each candidate, as a guarantee that each has been worked by him whose name, &c., it bears. Should a candidate have completed his work before 10 p.m. he may, by permission of the Committee, go away at once, after his worked paper has been taken by a member of the Committee.

15. Should a candidate break any of the foregoing rules, ask from or give information to another, or use unfair means of any description, he must be at once expelled the examination room, and his paper cancelled,

and the Committee will state on it the cause of his expulsion.

16. On these examinations depend large grants of public money. On their being fairly, honestly, and impartially carried out depends the continuance of the system. The Committees are intrusted with this duty. They will see, then, how necessary it is to be extremely careful in conducting them, and to insist on the foregoing rules being complied with to the letter. They are therefore required to sign and forward this form with each set of worked papers.

* It will, therefore, be desirable to make some arrangement for the candidates to

retire within the room.



SYLLABUS OF THE SUBJECTS IN WHICH CERTIFI-CATES AS TEACHERS OF SCIENCE ARE GIVEN BY THE DEPARTMENT OF SCIENCE AND ART.

The following Syllabus has been prepared in order to afford candidates for certificates as teachers of Science, some guide to their reading; but it must be understood that the questions in the examination need not necessarily be on the specific points enumerated, but are of as practical a nature as possible in the subjects of which the outlines are here indicated.

The examination is both by paper and vivâ voce, and satisfactory evidence may be required of the teacher's power of giving information to a class. The groups are divided as shown, the examination in each subject being distinct, so that candidates may, if they desire it, take a certificate only in one subject of a group. Mention is made of text-books solely to afford a candidate some assistance in selection and a general idea of the scope of the examination, and not at all to confine his reading to those works or to assert that they are the best on the subjects they treat of.

Any certificate obtained at the examination may be raised, by reexamination, in the next or any following November to a higher grade.

A Course of Lectures as detailed below, on "Preparation for obtaining "Science Certificates and the Method of teaching a Science Class," has been delivered by direction of the Lords of the Committee of Council on Education. The lectures may be purchased, price 2d. each, at the book stall, South Kensington Museum, or on application by letter, enclosing postage stamps, to the Secretary, Department of Science and Art, South Kensington, London, W.

Group I. - Geometrical Drawing, &c. Prof. T. Bradley.

,, II. - Mechanical Physics - Rev. B. M. Cowie, M.A., III.- Experimental Physics - Prof. Tyndall, F.R.S.

IV. - Chemistry - - - Prof. Hofmann, F.R.S.

, V. - Geology - - - Prof. Ramsay, F.R.S.

Mineralogy, &c. - Prof. W. W. Smyth, M.A., F.R.S., VI. - Zoology - - Prof. Huxley, F.R.S.

,, VII. Botany - - Edwin Lankester, M.D., F.R.S.

Navigation and Nautical J. Riddle, F.R.A.S.
Astronomy.

Physical Geography - Dr. G. Kinkel, F.R.G.S.

A Second Course has been delivered, of which the following have been published:—

Lecture I. - Vegetable Physio- Edwin Lankester, M.D., 3rd February. logy and Econo- F.R.S.

Lecture II. Mechanical Physics Rev. B. M. Cowie, B.D. 10th February.
-Lecture IV. Mining - W. W. Smyth, M.A., 24th February.
F.R.S.

SYLLABUS.

GROUP I.

PRACTICAL PLANE, AND DESCRIPTIVE GEOMETRY, MECHANICAL and Machine Drawing, and Building Construction.

This group consists of three subjects, viz.,—(first subject) Practical Plane, and Descriptive Geometry. (Second subject) Mechanical and Machine Drawing. (Third subject) Building Construction. And it is open to the candidate, to pass in either of the subjects alone, or in all, but a teacher will not receive any payments for Subjects II. or III. until he is certificated in I.

Subject I.-Practical Plane, and Descriptive Geometry.

Practical Geometry, plane and solid; required by architects, engineers, mechanists, shipbuilders, and others employed in arts of construction.

The candidate is expected to have acquired readiness in the use of the usual drawing instruments and materials, to be skilful in drawing lines and circles in Indian ink, plain or dotted, of different degrees of fineness; drawing parallel equi-distant lines, at least six inches long, and from five to twenty or thirty in an inch; drawing from ten to thirty lines, passing through one point and forming equal angles; dividing by trial lines and arcs into any number of equal parts. He should also be able to mend his drawing pens and other instruments, and to verify his rulers, &c.

Constructions in Plane Geometry.

 To draw lines through given points, in every position, either parallel, perpendicular to, or to form any proposed oblique angle, with given lines.

The use and construction of the protractor, and of the "scale of chords" for these purposes, should be understood, and the deduction of certain angles from the direct division of the circle.

To draw circles or arcs, through given points, to touch given lines or circles, and, conversely, lines to touch circles.

Required in drawing framework for machinery, architectural designs, ornamentation, &c.

3. The principles of drawing symmetrical forms by means of co-ordinatesto the axis of symmetry.

This is the basis of all drawing, of all objects of construction, which are universally symmetrical, not only in architecture, civil and naval, but in machinery and engineering works of all kinds.

 Constructions of figures similar to given rectilinear or mixtilinear figures.

Here the construction and use of "scales" plain and comparative, should be thoroughly understood and explained, and the principles of the diagonal and the vernier subdivision. Also the mode of reducing or enlarging drawings by means of similar rectangles, termed squaring a drawing. The use of the sector and of proportional compasses, and of the pentagraph and eidograph, in facilitating copying should be known.

- To construct rectilinear figures similar to given ones, but with a proposed area.
- 6. To determine by construction numerical quantities such as \sqrt{m} ; $\sqrt{a^2+b^2}$, &c.
- 7. To construct a triangle, any three parts being given.

Used in levelling, surveying, and the determination of heights and distances. Great accuracy, neatness, and distinctness of construction, will be insisted on: Geometrical drawing is valueless unless it possesses these requisites. A few illustrations of constructions on the ground, by means of a "chain," pins and cords, necessary in surveying, and "setting out" buildings and earthworks, may be added to the course, as well as the solution of a few elementary problems by means of the compasses alone.

8. The delineation of a few of the curve lines required in the arts, such as the ellipse, cycloidal curves, the involute and sinusoid, with the graphical method of determining their tangents and normals.

Required in designing elliptic arches, oblique bridges, teeth of wheels, cam-work, screws, &c.

- Practice in tinting and shading with Indian ink, so as to express curved surfaces and shadows.
- For the preceding part of the course, a fair knowledge of the first six books of Euclid is strongly enjoined, some acquaintance also with trigonometry will be of service, as without such previous knowledge, the learner is simply copying what is set before him, and cannot attain the highest skill in drawing.

Constructions in Solid Geometry.

(Descriptive Geometry.)

Preceded by explanations of the term projection, and of the necessity for it, in order to express graphically, on a surface, solids of any kind; the distinction between orthographic and perspective projections; their uses, and general principles which are the foundation of their practical application.

Orthographic Projection.

- Why the projections, of any solid consisting of a combination of geometric forms, on two or three co-ordinate planes are necessary to show the form and dimensions of that solid.
- Meaning of the terms plan, elevation, profile, section. The principle of the representation of surfaces by the projections of their generators, or of equi-distant horizontal sections termed contours. The direction and inclination of an indefinitely extended plane given by its contours, or by its traces on any two co-ordinate planes.
- These principles should be quite familiar to the candidate, and will be tested by making him draw plans, elevations, and sections of simple solids, as prisms, pyramids, cones, spheres, cylinders, and of symmetrical solids formed by their combinations.
- A few of the problems relating to points, lines, planes, and curved surfaces, will be required, as—
- To draw lines and planes parallel or perpendicular to each other, to contain given points or lines, and the limits of the possibility of solution of any problem should always be understood.

2. The preceding constructions combined and applied to determine by their projections the simple solids before mentioned, when they are not symmetrically situated with respect to the supposed planes of projection.

3. Applications to the intersections of surfaces, and of the development

of such as admit of it.

This may be considered the most important part of descriptive geometry to the artizan, as it is required in all arts of construction. The mason, carpenter, and shipwright, workers in tin-plate, boiler makers, &c., would all be benefited by a knowledge of it.

This application has been termed Stereotomy, and better and more significantly in French, "Coupe de pierres."

Much practical knowledge of the subject, arising from their pursuits, is possessed by workmen, while the want of a scientific knowledge of it compels architects, engineers, and their drawing clerks to leave to the workmen the execution of their conceptions which they cannot themselves design.

4. The solution by construction of the spherical triangle from any three given parts, is mentioned.

> As important to masters, mates, and others engaged in any kind of astronomical calculations.

Isometric Projection.

Is usefully employed in the representation of works chiefly of a rectangular form, such as timber framing, canal-locks, and many parts of machinery; its use is much increasing: it is readily understood, and can be practised by anyone who has gone through the first two articles of this section.

Perspective Projection.

May be taken up, but will not be insisted on as it is rarely used except by architects to represent buildings (not yet executed), as they would appear to the eye at any spot from which they could be viewed, and the power of applying it for this purpose is possessed by many who know little of the really easier subject of descriptive geometry; but as its application by the architect must be subordinated to artistic taste, this consideration excludes it, in some measure, from a purely. geometrical course.

No one, however, can be considered a scientific draughtsman unless he can apply perspective projection to the projection of shadows, the projections of the sphere, the constructions of maps and dials, and

some other uses.

For the second division of this course, in addition to what was before indicated, a competent knowledge of the theorems relating to the line and plane (Euclid, Book XI.), and an acquaintance with the leading properties of the conic sections, the geometry of the sphere, and some spherical trigonometry is important, it cannot be too urgently recommended to all persons wishing to master this course. to study such works as "Geometry, Plane, Solid, and Spherical" of the Library of Useful Knowledge, and Mr. Bell's, in Chambers' Educational Course.

Geometry, Plain, Solid, and Spherical (Library of Useful Knowledge) is especially recommended as a work to be studied on Theoretical Geometry.

Text-Books for Practical Plane Geometry.—Bradley's Geometrical Drawing; Burchett's Practical Geometry; Practical Geometry, Linear Perspective and Projection (Library of Useful Knowledge).

For Descriptive Geometry.—Bradley's Geometrical Drawing; Hall's Elements of Descriptive Geometry for Students in Engineering.—Heather's Descriptive Geometry. Also the following French Works, which are mentioned in consequence of the great deficiency of English Works on Geometrical Drawing.—Elémens de Géométrie Descriptive, par S. F. Lacroix; Traité de Géométrie Descriptive, par Levebure de Fourcy; Nouveau Cours raisonné de Dessin Industriel, par Armengaud, aîné, et Armengaud, jeune, et Amouroux; Bardin's Works on Descriptive Geometry.

Subject II.—Mechanical and Machine Drawing.

The candidates in Subjects II. and III. will, some time before the examination, have specifications of subjects given to them, of which they will be required to prepare drawings before the examination. These drawings must be bond fide their own. The candidates may be examined on them, and if the results be satisfactory, they will count towards their certificates, but they will only be taken into consideration when it is clearly seen from the regular examination that the candidate is qualified for a certificate.

The application of the foregoing Subject I. to the drawing of machinery, in which great accuracy and neatness of drawing will be insisted on.

The candidate will be required to take measurements with calipers, &c., and to make drawings, elevations, and sections of a simple machine, or of parts of one, set before him. Also to draw a portion of a machine from written dimensions and description. He will be required to have sufficient knowledge of the principles of machinery, gearing, &c., to be able to make working drawings of a machine or portions of a machine from a rough sketch, applying the power to the greatest advantage, and obtaining such power or changes of motion as are required. In fine, such knowledge and readiness as would be required of a good draughtsman in an engineer's office.

Subject III.—Building Construction, or Maval Architecture.

(See previous Subject.)

The candidate will be required to possess sufficient knowledge of construction—(1) to apply the various materials used in building to their greatest advantage; (2) to be able to make detail and working drawings showing a knowledge of the methods of construction and the framing of ordinary roofs, bridges, &c., whether of wood, iron, or masonry; (3) to frame estimates and take out quantities.

Neatness, accuracy, and facility in drawing will be insisted on, and the general requirements in this Subject will be such as would be possessed by a good draughtsman in an architect or builder's office, with a slight scientific knowledge for the proper application of the materials he is required to work with.

N.B.—Naval Architecture may be taken instead of Building Construction; the same description of attainments will be required.

GROUP II.

MECHANICAL PHYSICS.

This group is taken under two subjects.

Subject I.—Mechanics as a Science, or Theoretical Mechanics.

Composition and resolution of forces. Forces acting on a point—on a rigid body. Parallel forces. Centre of gravity. Theory of moments or couples. Principle of virtual velocities. The mechanical powers. Friction. Equilibrium of roofs and arches.

Dynamics. Laws of motion. Uniformly accelerated motion. Motion by gravity Variable forces. - Projectiles. Centrifugal force. Motion on inclined planes—on curves. Pendulums. Motion of rigid bodies, free or constrained. Moment of Inertia. Centre of oscillation-of percussion. Motion of flexible bodies, such as a musical string.

Hydrostatics, Hydrodynamics, and Pneumatics, Mechanical properties of liquids. Law of pressure. Centre of pressure. Laws of floating bodies. Capillary attraction. Laws of fluid motion, through open

channels, closed pipes, or orifices.

Mechanical properties of elastic fluids. Theory of barometers. nexion between pressure, temperature, and volume. Specific heat. Weight of atmosphere. Use of barometer in calculating heights.

In this subject the candidate will have to show a mathematical knowledge of the laws of Mechanics, and must be able to prove from

first principles the principal theorems.

The books recommended for study are—Whewell's Elements of Mechanics, or Snowball's; Moseley's Engineering Architecture; Natural Philosophy, by Dr. Golding Bird and Mr. Brooke; Goodwin's Elementary Course.

Subject II.-Mechanics as an Art, or Applied Mechanics.

General principles of mechanism. Elementary combinations. When the connexion is by rolling contact, sliding contact, wrapping connectors or linkwork, with constant or varying velocity ratio, and constant or

varying directional relation.

Machines of ordinary occurrence must be thoroughly understood and particular parts to be described and drawn: such as cranes; lathes; drills: planing, punching, boring, shaping, and slotting machines. Spinning and weaving machinery. Mode of calculating power of machinery. Dynamometers, indicators, &c.

Materials. The general properties of materials. Elasticity. Weight. Specific weight. Mechanical work. Work done by pressure, by impact, by expansion of elastic gases and steam, by animal muscular

Resistance to expansion, to compression, to rupture. Friction of Its importance in construction. Resistance of fluids to solids. bodies moving within them. Adaptation of form and material for maximum resistance. Beams of greatest strength. Construction of roofs, arches, stone and timber bridges, suspension bridges, and tubular girders.

Hydrostatics, Hydrodynamics, and Pneumatics. Pressure on floodgates; tocks; water-wheels; turbines; water-pressure engines; breakwaters. Hydrometers. The syphon. Hydraulic ram. Pumps. Diving bell. Condenser. Windmills. Steam-engines, stationary, marine, locomotive. The steam hammer. Water supply to towns.

Theory of tides, in the open sea, and in rivers.

In this subject the candidate will be expected to show how the principles are applied in actual practice: he will be expected to show by clear well-drawn sketches, his acquaintance with parts of machines. The candidate will have tools and models put before him, with some of

which he must show he is familiar, and that he can explain their use

and construction.

Books recommended,-Willis's Mechanism; Baker's Elements of Mechanism; the books in Weale's Series which treat on the subjects specified. Twisden's Practical Mechanics; Goodeve's Elements of Mechanism.

GROUP III.

EXPERIMENTAL PHYSICS.

This group is taken under two subjects.

Subject I.—Acoustics, Light, and Heat.

Acoustics.

The candidate ought to know the manner in which sound originates, and is propagated; its velocity in different media, and how its velocity

through air is affected by density and temperature.

He ought to know the origin of musical sounds; of pitch; of harmony and discord; to commit to memory the rates of vibration of the several notes of the gamut; to be able to make sonorous vibrations visible by means of glass plates and membranes; to calculate the length of sonorous waves, and to determine practically the number of vibrations due to any particular note. He ought therefore to understand the construction and use of the Syren.

He ought to be able to describe and illustrate the condition of a vibrating string, or column of air at its nodal points and ventral segments and

to explain echos and resonance.

Light.

The candidate ought to know how its velocity was first determined from

observations upon Jupiter's satellites.

He ought to be able to devise a simple means of exhibiting both the reflection and refraction of light; to be able to state the laws of both; to explain what is meant by total reflection; and to apply it to the explanation of the Mirage of the Desert, the Phantom Ship, and other similar phenomena.

He ought to be able to explain why the image in a plane mirror must appear as far behind the mirror as the object is in front of it; why a stick appears bent when dipped obliquely into water; and why the bottom of a river or lake, or of a basin which holds water, appears to

be nearer to the surface than it really is.

He ought to be able to determine the positions of the foci of spherical mirrors, both concave and convex; to describe the characters of their images, whether erect or inverted; magnified or reduced; and to do

the same for convergent and divergent lenses.

He ought to know the construction of the human eye; the conditions of distinct vision, the use of spectacles; and to be able to describe a simple form of the reflecting and refracting telescope and of the microscope.

He ought to know the constitution of light; to be able to describe the spectrum produced by refraction with a prism; to explain the origin

of colours, and to give a clear explanation of the rainbow.

Heat.

The candidate ought to be able to describe the construction and graduation of an ordinary mercurial thermometer; to understand the scales of Fahrenheit, Celsius, and Reaumur.

He ought to have clear ideas of conduction and radiation; to be able to devise some simple means whereby the conductive and radiative powers of different bodies may be determined; to explain fully the formation of dew, and to state the conditions favourable to its production.

He ought to know the effect of heat upon the volumes of bodies; to know what is meant by the coefficient of expansion, and how it may be determined; to give illustrations of the enormous power of heat in producing expansion; to state exceptional cases; to know the manner in which heat is propagated through liquids and gases, as distinguished from ordinary conduction; and to be able to combine two metals possessing different coefficients of expansion, so as to form a compensating pendulum.

He ought to know the meaning of latent heat and of specific heat, and to illustrate both by reference to ice, water, and steam; he ought to be able to show the influence of the high specific heat of water upon

an island climate.

He ought to know the strict physical meaning of ebullition; and the influence of pressure upon the boiling points of liquids; he ought to have a general knowledge of the origin of winds and clouds, and to be able to explain the fact that the rain-fall upon the south-west side of a mountain chain in England and Ireland is much more copious than on the north-east side.

Subject II .- Magnetism and Electricity.

Magnetism.

The candidate ought to know the action of one loadstone upon another which is freely suspended, or set afloat upon a liquid; he must have a perfectly clear notion of magnetic polarity, and of the action of magnetic polarity.

netic poles upon each other.

He must know the difference between the action of magnetised and unmagnetised steel upon a magnetic needle; also the difference between soft iron and hard steel, with regard to their acceptance and retention of the magnetic condition; (coercive force).

He must be able clearly to state the condition of a mass of soft iron when under the influence of a magnet, and in virtue of which condi-

tion the iron is attracted; (magnetic induction).

He must be able to describe the action of the earth upon a magnetic needle; must know the meaning of declination, inclination or dip, and of secular and diurnal variation; the action of the earth upon a bar of soft iron according as it is held in the direction of the dip or at right angles to this direction; finally, the effect of percussion in rendering the condition assumed by the bar of soft iron a permanent one.

He ought to be able to compare accurately the strength of one magnet with that of another, and to state how the relative intensity of the earth's magnetism at two points of its surface may be ascertained.

Frictional Electricity.

The candidate ought to know various simple ways of exciting electricity to be clearly informed as to the duplex character of the force; to know the condition of the rubber as well as that of the body rubbed; and to be conversant with various forms of electroscopes and electrometers.

- He ought to know the foundation of the terms vitreous and resinous, positive and negative; to be able to illustrate the action of two electrified bodies upon each other; and to tell at once whether a body is positively or negatively charged.
- He ought to have a clear knowledge of electric conduction, insulation, and induction; and be able to explain the state of a neutral conductor when acted upon by an electrified body; he ought to be able to prove, experimentally, that though we cannot by breaking a magnet obtain two halves each with a single pole, we can by breaking an electrified body obtain two halves each charged with a single electricity.
- He ought to be able to explain the influence of points and flames when attached to an electrified conductor; and to describe the action of lightning conductors.
- He ought to be able to describe the electric machine, and the electrophorus; and to explain the action of the condenser and of the Leyden jar.
- He ought to be able to state the principal effects of the electric discharge; to state the atmospheric conditions necessary to the production of a thunderstorm; and to give a clear account of the so-called return stroke.

Voltaic Electricity.

- The candidate ought to be able to state precisely how voltaic electricity may be generated; to describe Volta's pile, and his crown of cups; and also the batteries of Daniell, Grove, and Bunsen.
- He must have a clear conception of what is meant by the direction of an electric current; and be able to illustrate in the fullest manner the action of a current upon a freely suspended magnetic needle. Given the direction of the current, he must be able to state how the needle moves; given the movement of the needle, he must be able to infer from it the direction of the current.
- He must be able to describe fully the action of a current upon soft iron; and to infer from the direction of the current the nature and position of the magnetic poles, which it excites.
- He must be well acquainted with the chemical reactions which take place both in the batteries, mentioned above, and also in other liquids through which the current may be sent.
- He must be able to measure the strength of an electric current, and he is strongly recommended to master thoroughly the law of Ohm, regarding the mutual relations of electromotive force, resistance, and strength of current.
- He ought to be acquainted with the so-called polarisation of metallic plates between which a current passes through a liquid, and to show how this is avoided in Grove's battery.
- He ought to be able to give a clear description of some one form of the electric telegraph.
- He ought to be acquainted with the physiological effects, and with those of light and heat produced by the voltaic current; and to show the dependence of the heat on the strength of the current, and on the resistance which it encounters.

It would also be well to master as much of the phenomena of induced currents as would enable the candidate to explain the action of the

galvanizing apparatus used by medical men.

Note.—The candidate will perceive that this list is long because the objects to which he is to devote his attention are separately specified. Definition is thus given to his studies and their precise scope marked out for him. He is recommended to repeat with his own hands, as far as it is in his power to do so, the experiments which he finds described in good handbooks of Natural Philosophy; this will give a certainty to his knowledge and an interest to his pursuits which mere reading can never confer. The first requisite demanded of him on his examination will be that, however small his knowledge, it shall be well digested and sound.

Text-Books: - Lardner's Handbook of Natural Philosophy; Natural Philosophy, by Dr. Golding Bird and Mr. Brooke.

GROUP IV.

CHEMISTRY, INORGANIC AND ORGANIC.

This group is taken under two subjects.

Subject I.—Inorganic Chemistry.

The general principles of chemical philosophy. Laws of combination.

Combining weights and chemical equivalents. Combining volumes. Chemical symbols and their use in the explanation of chemical changes. .. The atomic theory.

The non-metallic elements: Oxygen. Combustion.

Hydrogen. Water. Chemical composition and properties. Adaptation for domestic purposes. Hardness, permanent and temporary. Nitrous oxide, nitric oxide. Nitric acid. Nitrification. Nitrogen.

Ammonia.

Process of carbonization. Carbonic oxide. Carbonic acid. Carbon. Marsh gas. Olefiant gas. Manufacture of coal gas.

Sulphur. Sulphurous acid, sulphuric acid. Sulphuretted hydrogen.

Bisulphide of carbon. Hypochlorous acid. Bleaching agents and theory of bleach-Chlorine. Chloric acid and perchloric acid. Chloride of nitrogen.

Bromine. Bromic acid and hydrobromic acid.

Iodine. Iodic acid, periodic acid, and hydriodic acid.

Fluorine. Hydrofluoric acid.

Chlorides of carbon.

Hypophosphorous acid, phosphorous acid. The several modifications of phosphoric acid: ordinary phosphoric, pyrophosphoric, and metaphosphoric acids. Theory of polybasic acids. Phosphoric acids. phoretted hydrogen. Chlorides of phosphorus. Manufacture of matches.

Boron and boracic acid.

Silicium and silicic acid.

.The metals: Potassium. Manufacture of nitre. Manufacture of gunpowder. Theory of the action of gunpowder. Sodium. Manufacture of carbonate of soda.

Barium. Strontium. Calcium. Mortars.

Magnesium, Aluminium. Manufacture of glass and porcelain.

Manganese, Iron. Composition and properties of cast iron, wrought iron, and steel.

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Cobalt. Nickel. Chromium. Zinc. Cadmium. Copper. Lead. Manufacture of white lead.

Bismuth. Mercury. Tin. Arsenic. Course of analysis in cases of poisoning.

Antimony. Silver. Gold, and platinum. Their principal compounds with the non-metallic elements.

Outline of qualitative analysis. Reactions of the principal mineral acids and bases. Course pursued in the application of these reactions to the analysis of a mixture of several acids and bases.

The following is the list of Apparatus and Re-agents with which Candidates make their analysis at the examination:—

APPARATUS.

Test tubes and stand.
Metal filter stand.
Wash bottle containing distilled water.
Spirit lamp.
Black blowpipe.
Charcoal for blowpipe experiments.
Iron spoon.

Iron spoon.
Tongs.
Pestle and mortar.
Porcelain dishes.

Sulphuric acid.

Watch glasses.
Porcelain crucible.
Triangles.
Test tube cleaner.
Platinum wire and foil.
Funnels.
Cut filters.
Sulphuretted hydrogen apparatus.
Platinum crucible.
Herapath's blowpipe.
Stirring rods.

RE-AGENTS. In the liquid state.

Hydrochloric acid.
Nitric acid.
Hydrosulphuric acid.
Potassa.
Ammonia.
Chloride of ammonium.
Sulphide of ammonium.
Carbonate of ammonium.
Phosphate of sodium.
Chloride of barium.
Chloride of calcium.
Lime water.

Sulphate of potassium.
Sulphate of magnesium.
Chromate of potassium.
Oxalic acid.
Tartaric acid.
Acetic acid.
Hydrofluosilicic acid.
Oxalate of ammonium.
Acetate of lead.
Sesquichloride of iron.
Ferrocyanide of potassium.
Chloride of platinum.
Nitrate of silver.

In the solid state.

Carbonate of sodium. Nitrate of potassium. Cyanide of potassium. Borax.

Sulphate of calcium.

Lime. Sulphate of iron. Blue and red litmus paper.

Subject II .- Organic Chemistry.

Ultimate analysis of organic bodies. Calculation of an empirical formula. Methods of controlling an empirical formula. Determination of the equivalents of organic acids and bases, examination of products of decomposition, determination of the vapour-density of volatile bodies. Law of substitution.

The chemical history of the Cyanogen group. Cyanogen. Hydrocyanic acid. Cyanic acid and urea. Fulminates. Cyanuric acid. Sulphocyanic acid. Chlorides of cyanogen.

Amylaceous and saccharine substances. Fermentation. Alcohol, and its homologues. Ethers, simple and mixed. Oxidation of alcohol, Aldehyde and acetic acid, and their homologues. Anhydrides, simple and mixed. Compound ethers. Diatomic alcohols and their acids. Glycol and oxalic acid. Triatomic alcohols. Glycerine. Fatty and oily bodies.

Ammonia and its derivatives. Amides and amines: their classification.

Examples of natural alkaloids.

Principal colouring matters. Indigo and its derivatives. Examples of products formed by destructive distillation.

The chief constituents of the vegetable and animal organism, fibrin, albumen, casein, &c.

The chamical mineral are

The chemical principles of agriculture.

The chemical principles of the process of nutrition and respiration in

the animal organism.

Text-books.—Graham's Elements of Chemistry, Miller's System of Chemistry, Fownes' Manual of Chemistry, Gregory's Outlines of Chemistry, Abel and Bloxam's Handbook of Chemistry, Galloway's Qualitative Analysis.

GROUP V.

GEOLOGY AND MINERALOGY.

This group is taken under two subjects.

Subject I.—Geology.

 The division of rocks into three great classes, aqueous, igneous, and metamorphic.

 The mode of formation of stratified rocks,—marine strata—delta formations—freshwater beds,—the sign by which you can distinguish these.

3. The mode of occurrence of igneous rocks, ashes, lavas, and dykes.

4. Volcanoes and volcanic phenomena.

5. The theory of central heat.

6. Elevation and depression of land.

The ordinary mineral substances that enter into the composition of rocks.

8. Fossilization of organic bodies.

9. Table of geological formations, including those larger divisions absent in Britain.

10. Theory of metamorphism of rocks.

British Strata.

 Description of the Cambrian strata and Silurian strata, their lithological characters, disturbances and chief fossils.

Description of the old red sandstone and Devonian rocks, character and fossils. Origin of cleavage. Slate and slate quarries, building-

stones, limestones, and marbles.

3. The carboniferous limestone and coal measures. Character, fossils, and mode of formation. Origin of the coal of the coal-measures, and its mode of occurrence. Mode of occurrence of the ironstone of the coal measures. Various kinds of coal, and the relation of anthracite coal to disturbance of strata. Lime quarries, marbles, and building stones. Clay pits and potteries of the carboniferous strata. Fire clay. Alum shale.

4. The Permian rocks. Their strategraphical relations to the underlying strata, composition of rocks, fossils, and building-stones.

5. The new red sandstone (or Trias), its subdivisions, fossils, building-

stones, sand pits, rock salt, and brine springs.

6. The Lias. Its subdivisions, chief fossils, building-stones, and other hydraulic limestones, and clay pits.

. 7. Oolitic rocks. Subdivisions, leading fossils, building-stones. Lime-

stones. Clay pits, and other economic products.

8. The Purbeck and Wealden strata. Origin, subdivisions, chief fossils, building-stones, and marbles. Ironstones and limestones. Clay pits.

Subdivisions, lithological characters, fossils, 9. Cretaceous rocks. building stone of lower greensand. Gault, its phosphatic nodules and general uses. Upper greensand, chalk, &c. Building stones.

Origin and uses of chalk-flints.

10. Eccene, or older Tertiary beds. Subdivisions, alternation of marine and freshwater beds, chief fossils, limestones and building stones, clays for bricks and potteries.

11. Crag. Its subdivisions, chief fossils, phosphatic remains.

12. Disturbance and denudation of strata.

13. Unconformities, faults, and fractures.

14. The causes of gaps in the succession of strata, or of breaks in the succession of life in time.

15. Water-bearing strata, and underground drainage. Artesian and other wells.

16. British rocks in which ores of metal are found, and the general mode of occurrence of these ores in beds or lodes.

17. The rules that ought to guide the miner in sinking for coal and other minerals, when the beds in which they lie are concealed by over-lying and unconformable strata.

18. The occurrence of stream tin, gold, &c., in superficial detritus.

19. The chief differences in the nature and mode of occurrence of various formations in areas widely separated from each other.

Text-books.—Lyell's Principles of Geology; Lyell's Elements of Geology; Phillips' Manual of Geology; Jukes' Manual of Geology; Page's · Introductory Text-Book: Page's Advanced Text-Book.

Subject II.—Mineralogy.

A. Instruction in this subject should commence with a distinct understanding of the characters by which minerals, properly so called, are to be distinguished from other inorganic substances, and of the position of this science in relation to the collateral sciences of

physics, chemistry, and geology.

B. Crystallography, as the essential means of appreciating the forms naturally assumed by almost all inorganic bodies, must commence with the needful geometrical definitions, proceed to the grouping of the various crystalline forms into systems, consider the laws by which the derivation of one form from another within the limits of the same system is determined, and explain the combination of various simple forms in the faces exhibited by compound crystals. It is also important to study the deviations from regularity which are commonly presented in nature, and the methods of measuring those elements which remain constant.

c. The various kinds of aggregation exhibited by crystalline substances are also to be considered, especially with reference to masses of the

useful minerals, and of crystalline rocks.

D. Next in order will follow the other physical characters of minerals; 1st, in relation to their substance, as cleavage, fracture, hardness, and specific gravity: 2ndly, in relation to the effects of light, as transparency, refraction, lustre, and colour; 3rdly, as to their electric and magnetic properties.

E. The chemical characters of minerals, and the most convenient modes of testing them; 1st, by aid of the blowpipe; 2ndly, by the

moist way.

F. Pseudomorphism, or the remarkable phenomena presented by minerals which have the composition of one mineral coupled with the form

of another.

G. The physiography or systematic description of minerals. This last division should include all the more remarkable varieties as well as species, and should take especial note of the modes and places of occurrence, as well as of the association of particular groups of minerals in certain veins or formations.

As text-books may be recommended—

Professor Ansted's Elementary Course of Mineralogy and Geology. London, 1856.

Nicol's Elements of Mineralogy. Edinburgh, 1858.

Dana's Manual of Mineralogy, 1851.

Bristow's Dictionary of Minerals. Longman & Co. 1861.

For more advanced students-

Brooke and Miller's Mineralogy. London, Longman, 1852. On Crystallography. Rev. W. Mitchell, in Orr's "Circle of the Sciences." London, 1856.

Dana's System of Mineralogy. 4th edition. Putnam, 1854. Naumann's Mineralogie. Leipzig. Williams and Norgate, London.

Breithaupt's Paragenesis der Mineralien. Freiberg, 1849.

Haidinger's Handbuch der Mineralogie. Vienna, 1845.

When it is intended to teach this subject with special reference to the practical working of minerals, the physiographical part will be occupied more particularly with certain of the useful species and their associated substances, and the following works may be consulted :-

W. J. Henwood on the Metalliferous Deposits of Cornwall and Devon.

Bischof, Chemical and Physical Geology, translated by the Cavendish Society. 1854.

GROUP VI.

ANIMAL PHYSIOLOGY AND ZOOLOGY.

This group is taken under two subjects.

The field presented by Natural History is such an exceedingly wide one, that candidates are advised to confine their studies to the subjects enumerated below, and to master these as thoroughly as possible. And as in the Natural Sciences, the knowledge which is obtainable by mere reading is of very little value, candidates are particularly recommended to study nature for themselves, and to become personally acquainted with the primary facts of Biological Science. Thus in Physiology, the fundamental truths relating to circulation, muscular contraction, and nervous action, may all be readily exemplified by simple experiments upon the common frog; and in Systematic Zoology and Botany, the careful study of the structure of the animal and vegetable forms enumerated under the head of "types" will furnish a better conception of the animal and vegetable worlds than any amount of mere reading. Candidates will therefore be expected to be thoroughly and practically acquainted with the fundamental facts of Physiology, and in Zoology, with all the most important and distinctive characteristics of such of these typical genera as are illustrated by British species.

Subject I.—Animal Physiology.

Candidates should have carefully studied what is stated upon the subjects enumerated below in any good handbook of Physiology.

The general properties of living matter in respect of form, structure, and chemical composition. The meaning of the terms organ, organization, function, development. The difference between high and low organization. The division of physiological labour.

Why the living organism wastes. The difference between vital and putrefactive decomposition. The conditions and ultimate products of vital decomposition. The living body considered as a

machine performing a certain amount of work.

Why food is necessary. The difference between the food of plants and that of animals. The nature of the substances which constitute the food of man. The proximate chemical composition of milk, flour, meat, butter, potatoes, oatmeal, peas, rice, tea, coffee, beer, wine, and spirits; and the distinction of the proximate elements of each into nutritious and innutritious.

Why digestion is necessary, and how that function is performed in the human organism. The structure of the organs by which the following substances are formed, and their uses: saliva, gastric juice. pancreatic juice, bile. How the nutritious products of digestion are separated from the excrementitious residuum. The process of absorption. The means by which absorbed matters are conveyed to all parts of the organism. The structure and composition of human blood. The course and mechanism of the circulation.

Why the elimination of waste products is necessary. Excretion of carbonic acid. The mechanical and physical principles involved in the performance of the respiratory process in man. The excretion of urea and uric acid. The structure of the urinary apparatus, and the mechanical and physical principles involved in its action. excretion of water as a part of the foregoing processes, and as effected by the skin. The structure and other functions of the skin. The mutual relations of the three great excretory apparatuses.

The conditions and sources of animal heat. The circulatory

system of man viewed as a hot-water warming apparatus. The fuel

of the animal economy and its sources.

Animal mechanics. The human body as a locomotive apparatus. The structure of bones and joints. The structure and properties of

The structure and functions of nervous matter. The offices of the spinal cord and brain. The nature and mode of action of the sensory organs. Reflex action. Habit, as acquired reflex action. Instinct. Intellectual and emotional operations.

The nature of death, and the difference between general and local

Local death:—1st, as a part of life; e.g. moulting, shedding of skin and teeth. 2nd, as opposed to life; e.g. sloughing and mortification.

General death:—1st, as the natural conclusion of life. 2nd, as arising from disease or injury. Usual commencement of death in the nervous centres, the heart or the lungs.

Reparative processes:—lst. Local, as exhibited in the reproduction of lost parts, healing of wounds, &c. 2nd. General, as shown in the reproduction of the individual by sexual generation. The origin and development of the embryo. The nutrition of the feetus and of the infant. Hereditary transmission, and the modification of physical and mental characters by education, as the basis of a rational belief in the possibility of human progress.

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Subject II.—Zoology.

1. Candidates should have carefully mastered the definitions of the sub-kingdoms, classes, and orders of the Animal Kingdom. They should understand and be able to explain the meaning of the terms employed in such definitions; and they should be able to refer any specimens that may be placed before them to their proper classes.

2. Candidates should be able to give fair answers to questions relating to any or all of the following subjects, and they should be able to identify, refer to their proper orders, and if called upon to do so, describe, the objects enumerated in each section under the head of "types." In almost all cases these "types" are British animals.

> By the term Natural History, of such and such an object, is meant such an account of it as is to be found in any standard modern work on Zoology.

i. The structure and mode of multiplication of infusorial animalcales and Foraminifera. The arguments which have been adduced for and against spontaneous generation. The luminosity of the sea, and the nature of the creatures which chiefly cause it. The natural history of the sponge of commerce. Types—Spongia,

ii. The meaning of the terms, zoophyte, coral, coralline. Natural history of the red coral of commerce. Common coral and coral reefs. What such reets are, where they are formed, are not hydra, grow. Natural history of the common freshwater polype, or hydra, " " medusæ" of the sea. Asexual What such reefs are, where they are formed, and how they multiplication as exhibited by these creatures. Types—Hydra, Sertularia, Plumularia, Actinia, Corallium, Fungia, Oculina.

iii. Starfishes, sea urchins, and Holothuriæ; their structure and habits, and the metamorphoses which they undergo. Natural and economical history of Trepang. Types—Uraster, Echinus.

iv. Natural history of the earthworm and the leech. Intestinal worms; their structure, propagation, and mode of entrance into animal bodies. Natural history of the Rotifera. Types—Lumbri-

cus, Hirudo, Distoma, Tænia, Ascaris.

The lobster and crayfish, as v. Natural history of Crustacea. exemplifying morphological and teleological laws. The process of ecdysis. Barnacles, acorn shells, and fish lice, as cases of extreme metamorphosis. The water flea as exemplifying asexual multiplication. Types—Cancer, Homarus, Astacus, Oniscus, Daphnia, Cyclops, Lepas, Balanus, Argulus.

vi. Natural history of spiders, scorpions, and mites. The "itch insect," centipedes, and millipedes. Types-Tegenaria, Scorpio,

Scolopendra, Julus.

vii. Insects; their mode of breathing as contrasted with that of spiders and crustaceans. The structure of their wings, and the mechanism of flight. The parts of the mouth and their modifications in beetles, bees, butterflies, bugs, and gnats. Structure of the eyes. Nature of stings, saws, and ovipositors. Natural and economic history of the blistering beetle, of the silk moth, of the bee, of the cochineal insect. Natural history of plant lice, of bugs, fleas, and lice. The house fly, blow fly, and gnat; wasps, humble bee, ichneumon flies; "black beetles," crickets, and locusts. The metamorphoses of insects. Types—Melolontha, Blatta, Libellula,

Phryganea, Coccus, Aphis, Bombyx, Apis, Vespa, Musca.
viii. The characteristic peculiarities of the nervous, circulatory, respiratory, and locomotive organs of mollusks in general. Organization of "sea mat" (Flustra). Ascidians and "lamp shells"

(Terebratula). Natural history of fresh-water and marine mussels. Nature of mother of pearl. Formation of pearls. Pearl fishery. Natural and economical history of the ovster. Organization of snails and slugs, periwinkles, limpets, whelks. Development of the young of the latter. Nidamental capsules. Cuttlefishes and squids. Pearly nautilus. The shipworm and Pholas. Mechanism by which mollusks bore. Types—Flustra, Ascidia, Terebratula, Unio, Mytilus, Ostrea, Pecten, Helix, Patella, Littorina, Buccinum, Chiton, Sepia, Loligo, Argonauta, Nautilus.

ix. Circulatory, respiratory, and reproductive organs of fishes. Their dentition. Natural and economical history of the lamprey, sprat, sardine, herring, pilchard, salmon, trout, eel, cod, haddock, sole, flounder, turbot, mackerel, tunny, sturgeon, skate, ray, dog fish, shark. Electrical fishes. Fishes which are capable of living in air. Pisciculture, or the artificial breeding of fishes. Types—Amphioxus, Petromyzon, Syngnathus, Cyprinus, Perca, Accipenser, Lepidosteus, Raia, Spinax.

x. Natural history of salamanders, newts, frogs, and toads, Metamorphoses undergone by their young. Types—Salamandra,

Triton, Rana.

xi. Circulatory and respiratory organs of reptiles as distinguished from those of fishes and amphibia. Natural history of snakes, lizards, crocodiles, turtles, and tortoises. Tortoise-shell. Shedding of the skin in reptiles. Types—Coluber, Pelias, Anguis, Lacerla, Crocodilus, Testudo, Chelone.

xii. Organs of locomotion, respiration, voice, circulation, and reproduction of birds. Structure and mode of growth of feathers, Development of the fowl's egg. Artificial hatching. Migration, and instincts of birds. Natural history of domestic birds; of the ostrich, the apteryx, the penguin, and the dodo. Types—Falco,

Corvus, Columba, Picus, Phasianus, Ardea, Struthio, Anser.

xiii. Organs of respiration, circulation, and reproduction of mammals. Production and nutrition of their young. Placental and implacental mammals. Nature of milk and of the lacteal glands. Peculiarities in the dentition of mammals. Natural and economic history of the domestic mammals; of the ivory and fur yielding mammals; of seals; of whales. The hybernation and migration of mammals. Characters of the orders of mammals. Types—Cercopithecus, Vespertilio, Erinaceus, Lepus, Elephas, Sus, Cersus, Bos, Ovis, Felis, Phoca, Phocana, Dasypus, Halmaturus, Ornithorhynchus.

xiv. The distinctive peculiarities of man. The characters of the principal races of mankind, and their geographical distribution.

Text-books for Physiology.—Carpenter's Animal Physiology, Bohn, 1859; Dr. Kirke's Manual: Andrew Combe's Physiology applied to Health and Education. For Zoology.—Dallas's Natural History of Animals; Orr's Circle of the Sciences; Gosse's Manual of Marine Zoology; Professor Green's Manual of the Protozoa.

GROUP VII.

BOTANY.

This group is taken under two subjects.

Subject I.—Vegetable Physiology and Economic Botany.

In this department the candidate will be expected to answer correctly questions on the following points:—

1. The properties of the principal elements entering into the composition Carbon, oxygen, hydrogen, nitrogen, sulphur, phosphorus, chlorine, iodine, silicon, potassium, sodium, calcium, iron.

2. The composition and properties of the compounds forming the principal part of the structure of plants. Cellulose, starch, dextrine, sugar, fixed oil, gluten, albumen, caseine. The saline compounds forming the ashes of plants.

3. The composition and properties of peculiar vegetable products. latile oils. Acids. Colouring matters. Alkaloids. Neutral principles. Chlorophyll.

4. The origin and growth of the vegetable cell. The tissues of plants. Cellular tissue. Intercellular organs. Epidermal tissue. Hairs. Stomates. Vascular tissue. Woody tissue.

5. The structure and functions of the organs of plants. The root. Spongioles. Absorption and excretion. Nature of vegetable food. The stem. Structure of Exogenous, Endogenous, and Acrogenous stems. The leaf. The forms of leaves. Exhalation. Stipules and bracts. The flower. Calycine, Corollal, Staminal, and Carpellary leaves. Development and nature of pollen. Ovules or seed buds. Vegetable impregnation. Embryo. Seed. Fruits; their nature and forms. The nature of the reproductive organs in flowerless plants.

6. The composition and nature of vegetable substances used by man as Distinctions between heat-giving and flesh-forming foods. Structure and geographical distribution of plants yielding starch,

sugar, oil, gluten, albumen, and legumin.

7. Properties of vegetable substances used in the arts and manufactures. Vegetable secretions used as dyes.—Indigo, madder, logwood, red sanders wood, quercitron, alkanet, arnotto, gall-nuts, myrobolans.

8. Materials used in the manufacture of textile fabrics.—Cotton, flax, hemp, coco-nut, jute, New Zealand flax.

9. Principal forms of timber trees, and their uses.—Oak, mahogany, teak, pine, &c.

10. Nature of tanning principles and plants yielding tannic acid.—Oak-

bark, valonia, catechu, kino, divi-divi, betel-nut.

11. Gums, oils, and resins used in arts.—Gum arabic, benzoin, rosin, turpentine, camphor, essential oils, coco nut oil, palm oil, other fixed oils, caoutchouc, gutta pertsha.

12. Substances obtained from the vegetable kingdom and used as medicines.—Opium, quinine, tobacco, jalap, scammony, gentian, aloes, rhubarb, senna, ipecacuanha, sarsaparilla, castor-oil, assafœtida.

myrrh, nux vomica, hemlock.

Text-books for Vegetable Physiology and Economic Botany.—Henfrey's Elementary Course of Botany; Van Voorst. Carpenter's Vegetable Physiology, edited by Dr. Lankester; Bohn. Schleiden's Principles of Scientific Botany; Bohn. A Manual of Structural Botany by M. C. Cooke. Archer's Popular Economic Botany; Reeve and Co. Lindley's Medical and Œconomical Botany; Bradbury and Evans.

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Subject II .- Systematic Botany.

In this department the candidate will be expected to demonstrate the

structure of plants from living specimens.

1. The distinctions between the three great classes of plants, Dicotyledons, Monocotyledons, and Acotyledons. Also of the groups Gymnosperms, Rhizanths, Dictyogens, Acrogens, and Thallogens.

2. The characters of the following orders of British plants should be mastered, and the typical genera recognized, and their structure

understood.

3. Algæ. The natural history and uses of sea-weeds. The microscopic structure of diatoms and desmids. Nature of the reproductive organs in this order. Types—Navicula, Desmidium, Conferva, Fucus,

4. Lichens. The natural history and uses of lichens. Structure of their reproductive organs. Types—Graphis, Collema, Parmelia.

5. Fungi. The natural history of mushrooms, puff-balls, moulds, blights, and toadstools. Their uses in nature. Types-Agaricus, Bovista, Torula, Aspergillus, Morchella, Mucor.

6. Mosses. The nature of their reproductive organs. Types - Bryum,

Sphagnum, Funaria.

7. Ferns. Nature of their rhizomes. Herbaceous and tree ferns. History of Development, and nature of reproductive organs. Types

-Polypodium, Hymenophyllum, Osmunda.

8. Graminaceæ. 'The history of grasses and their uses. Nature of the flower in this order. Useful plants of the order. Types-Phleum, Hydrochloa, Panicum, Agrostis, Arundo, Spartina, Avena, Festuca, Hordeum, Triticum, Secale, Nardus, Anatherum.

 Cyperaceæ. Sedges. Types—Carex, Scirpus.
 Liliaceæ. The lily tribe, its useful properties. 10. Liliaceæ. Types—Tulipa, Ornithogalum, Muscari.

11. Amaryllidaceæ. The family of the narcissus, snow-drop, snow-flake. Types—Narcissus, Galanthus.

12. Orchidaceæ. The orchis family. Structure of reproductive organs. Types—Orchis, Goodyera, Malaxis, Cypripedium.

13. Amentaceæ. The family of the hazel, chestnut, oak, willow, birch, beech, poplar, and hornbeam. The uses of these plants as timber, &c. Types-Quercus, Corylus, Fagus, Castanea, Betula, Myrica, Salix, Populus.

14. Urticaceæ. The nettle and hop tribe. Its relations to Moraceæ, Artocarpacæ, Cannabinaceæ, and Ulmaceæ. The nature of the stings of Urtica, and the bitter principle of the hop. Types-Urtica,

Parietaria, Humulus.

15. Euphorbiaceæ. The spurge family. Foreign forms and their uses. Croton, Cascarilla, Ricinus, Janipha. Apetalous and Polypetalous forms. Types—Euphorbia, Buxus.

16. Polygonaceæ. The buckwheat and rhubarb tribe. Types-Poly-

gonum, Rumex.

17. Primulaceæ. The primrose family. Theory of the peculiar position of stamens. Types—Primula, Lysimachia.

18. Labiatæ. The dead nettle tribe. Peculiar properties of this order. Types—Mentha, Salvia, Thymus, Nepeta, Lamium, Teucrium.

19. Scrophulariaceæ. The scrophularia tribe. Nature of the poisonous properties of the order. Types—Scrophularia, Digitalis, Verbascum, Euphrasia, Veronica, Melampyrum.

20. Boraginaceæ. The borage tribe. Peculiarities of their epidermis.

Useful species. Types—Cynoglossum, Borago, Echium, Myosotis

Lithospermum.

21. Solanaceæ. The tribe of deadly nightshade, henbane, tobacco, and potato. Useful and poisonous species. Types—Solanum, Atropa, Hyoscyamus, Datura. Digitized by GOOGLE

2. Ericaceæ. The heath tribe. Its distinction from Epacridaceæ.

Types—Erica, Arbutus, Vaccinium, Pyrola, Monotropa.

23. Compositæ. The composite family. The number of species and geographical distribution. Structure of the sub-orders Asteracea, Cichoraceæ, and Cynaraceæ. Types-Tussilago, Aster, Inula, Gnaphalium, Bellis, Artemisia, Achillea, Carlina, Carduus, Cichorium, Leontodon, Lactuca, Crepis.

24. Stellatæ. The Stellate tribe. Its relation to Cinchonaceæ and Caprifoliaceæ. The properties and useful plants of Cinchonaceæ.

Types-Galium, Rubia.

 Umbelliferæ. Umbel bearing plants. Character of inflorescence and flowers. Nature of fruit. Structure of cremocarp. Properties of the order. Types-Hydrocotyle, Sanicula, Eryngium, Apium, Sium, Æthusa, Œnanthe, Crithmum, Angelica, Pastinaca, Daucus, Torilis, Scandix, Conium, Coriandrum.

Cucurbitaceæ. Melon, cucumber, and gourd family. Useful plants of this order. Type—Bryonia.

27. Rosaceæ. The rose, apple, cherry, and plum tribe. Forms of the fruit. The useful plants of this order. Types-Prunus, Spiraa,

Fragaria, Rubus, Geum, Rosa, Cratægus, Pyrus.

28. Leguminosæ. The bean, pea, and clover family. Principal divisions Structure of the flowers and fruits. of the family. plants of the order. Types—Ulex, Trifolium, Vicia, Astragalus, Ornithopus.

29. Cruciferæ. Cabbage, turnip, and mustard tribe. Structure of the flowers and fruits. Useful plants of the order. Properties. Types-Nasturtium, Alliaria, Brassica, Sinapis, Armoracia, Iberis, Isatis, Crambe, Cakile.

30. Papaveraceæ. The poppy tribe. Properties and mode of collecting opium. Nature of fruit. Types—Papaver, Glaucium, Chelidonium.

The crow-foot tribe. Structure of abnormal 31. Ranunculaceæ. genera; Aconitum, Aquilegia, and Delphinium. Nature of poison in order. Types—Ranunculus, Clematis, Helleborus, Pæonia, Anemone.

Text-books for Systematic Botany.—Lindley's Vegetable Kingdom. For British Botany.—Bentham's Handbook of the British Flora, or Babington's Manual of British Botany.

GROUP VIII.

MINING AND METALLURGY.

This group is taken under two subjects.

Subject I .- Mining.

The Art of Mining embraces so wide a field of study that equal practical proficiency in its various branches is not to be expected; but those who wish to gain a general knowledge of it may be recommended to

direct their attention to the subjoined heads, viz.:

1. Geology and Mineralogy, more particularly those portions of the sciences which bear on the following subjects,—the nature and position in the earth's crust of the useful minerals, the classes of rock with which they are severally associated, the special character of heaves, throws, troubles, and all kinds of dislocation; the particular differences between beds and lodes, and their minerals, and the chief features of irregular repositories.

2. The methods of prospecting and searching at surface for ores and

other minerals.

3. Breaking of ground; the various implements employed, their form, dimensions, and weight; boring for shots; the various modes of firing charges. Heavy charges, how calculated and fired; rules for ensuring safety.

4. Deep boring, under what circumstances applicable,—apparatus for

description of varieties in use; lining of bore-holes.

5. Management and supervision; payment of men employed at mines, at surface and underground, varying in principle with the different classes of operation; reasons for tut-work or piece-work, and tribute or bing-tale under different circumstances. Calculations for cost of driving, sinking, tramming, &c.

6. Physical principles of ventilation; practice of mines where simple natural ventilation is employed; ventilation of large areas and of deep or complicated workings by guiding the natural current; artificial means, and their details, for promoting ventilation. Precautions to be

taken under specially dangerous conditions.

7. Illumination, of various kinds, their economy; safety lamps in all their best modifications; circumstances under which they should be

employed; precautions in their use.

8. Mechanical division of the subject. Strength of materials used in mines; human and horse power, principles and construction of machines to which they are applied. Hydraulic machines; construction of the water-wheels, turbines, and pressure engines most suitable to the various operations of mining. Steam engines, for pumping and for winding; arrangement and construction of the varieties most in use. Form and dimensions of boilers. Pumps employed in mines, mode of placing them; construction of the lifts; materials and details of the rods, setoffs, counterbalances, cisterns, and catches. Circumstances under which dams are erected in shafts or levels; mode of building them.

Tubbing of water from shafts; conditions under which it may be done; details of the operation with various materials, wood, brick, stone,

cast and wrought iron.

Rails, waggons, and tubs for underground conveyance; employment

of horses and of fixed steam engines for this purpose.

Raising of the mineral through the shafts; various methods in use; chains, ropes (of hemp or wire), their weight, &c. Details of the best application of drums, cages, guides, keeps, and safety doors. Pulleys and shaft frames or poppet heads; protection against over-winding;

safety clutches, &c. in case of breakage of rope.

9. Opening of ground; quarries and open work; driving of levels, various dimensions and directions according to circumstances; sinking of shafts, inclined or perpendicular; advantages of either kind under certain conditions; means of securing levels and shafts by timber or by walling; details of the various methods. Driving or sinking in heavy or running ground.

10. Working excavations; plan of laying them out, and means of security to be adopted whilst they are kept open. This will include the stoping of metalliferous veins, and the various modifications of post and

stall, long-work, &c., which are applied to stratified deposits.

11. Travelling in shafts; prevention of accidents by proper fitting and dividing; mode of placing ladders and sollars; lifting machine for men,

construction and advantages of.

12. Dressing of minerals. Arrangement of dressing floors. Construction of crusher and stamps; washing of coal; jigging, concentration, and separation of metallic minerals.

The student may be advised among other sources of information to

· consult the following works:-

De la Beche's Report on Cornwall and Devon. Greenwell's Treatise on Mine-Engineering. Dunn on the Winning and Working of Collieries. Hedley on Colliery Working and Ventilation. Evidence before Committees of the Houses of Lords and Commons on Acoidents in Mines. Reports of H.M. Inspectors of Coal Mines. Transactions of the Northern Institute of Mining Engineers.

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Subject II .- Metallurgy.

L. Introduction.

On certain physical properties of metals. Action of heat, specific gravity, crystallization, fracture, malleability, ductility, tenacity, conductivity of heat and electricity, opacity, lustre, colour. General considerations on metallurgical processes. Modes of occurrence of metals in nature, ores, reduction, smelting, roasting, liquation, slags.

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General remarks, calorific power, calorific intensity, classification of fuels, wood, peat, lignite, coal, charcoal, coke, gaseous fuel and gas furnaces, charcoal burning, coke burning, typical varieties of coke ovens, comparison of fuels with respect to calorific power. This important branch of the subject is treated with much detail.

III. Refractory materials employed in the construction of furnaces, crucibles, &c.

Fire-clays British and foreign, crucibles of various kinds, plumbago and its application to crucibles, manufacture of crucibles, fire-bricks, silica and its applications, Dinas fire-bricks, sand and sandstones.

IV. Special Metallurgy.

Copper.—Compounds of special importance in the metallurgy of this metal fully described, such as the disulphide, oxides, &c., ores of copper, copper-smelting in reverberatory and blast furnaces, reactions occurring in the process, kernel-roasting, 'wet' methods, of extracting copper from its ores, assaying of copper ores by 'dry' and 'wet' methods,

ship sheathing.

Zinc.—In describing the metallurgy of zinc and the following metals, the same plan will be followed as in describing the metallurgy of copper, that is to say, the compounds of special metallurgical importance will be first considered in detail, as well as the reactions upon which the various processes of smelting essentially depend, and the construction of the furnaces will be fully explained. Ores of zinc, English, Belgian, Silesian, and Carinthian methods of extraction, assaying of zinc ores brass, its history, properties and manufacture.

Lead.—Ores of lead, lead smelting in the 'ore-hearth,' low blast and reverberatory furnaces, lead-fume and various methods adopted for its

condensation, assaying of lead ores.

Silver.—Ores of silver; smelting of silver ores with lead; cupellation; desilverization of lead by Pattinson's process, also by that of Parkes; treatment of argentiferous copper by liquation; extraction of silver; amalgamation, the old Freiberg method and the Mexican; Ziervogel and Augustin's 'wet' methods; treatment of argentiferous copper-regulus; alloys of silver and copper; standard silver; assaying of silver ores and alloys.

Gold.—Modes of occurrence of gold in nature; extraction by amalgamation and by smelting with lead; chlorine-water as a solvent for the extraction of gold from certain ores; separation of gold from silver or parting by nitric and by sulphuric acids; alloys of gold with the preceding metals; standard alloys; assaying of auriferous ores and

alloys.

Mercury.—Ores of mercury; extraction in the Almaden, Idrian, and Hähner furnaces; in retorts in admixture with reducing agents; assaying

of the ores of mercury.

Antimony.—Ores of antimony; liquation of the native sulphide and its subsequent reduction by iron or other agents; alloys of antimony, type metal, &c.; assaying of the ores of antimony.

Bismuth.—Mode of occurrence in nature; its extraction from ores

containing it by liquation; alloys of bismuth.

Nickel.—Ores of Nickel; modes of extraction, generally by a combination of 'dry' and 'wet' processes; alloys of nickel, especially those known as German silver; assaying of nickeliferous ores and alloys.

Cobalt.—Ores of cobalt; smelting and preparation of zaffre and cobalt colours, smalts, &c.; separation of nickel; assaying of cobalt

ores

Arsenic.—Mode of occurrence in nature; arsenious acid or 'glass' of arsenic, generally obtained as a secondary product in the treatment of certain other ores, such as those of nickel, cobalt, &c.; modes of condensation of arsenical fumes; preparations of arsenical 'glass,'

Tin.—Ores of tin; smelting in reverberatory and blast furnaces; tin refining; varieties of tin in commerce; alloys of tin, with the preceding

metals, bronze, gun-metal, bell-metal, &c.; assaying of tin-ores.

Iron.—Malleable iron; steel; pig-iron; ores of iron, direct extraction of iron in the malleable state from the ore; smelting of iron in the modern-blast furnace; construction of blast-furnaces and blowing machines; economic application of the waste gases; conversion of pig into bar iron in open hearths and in the reverberatory furnace; manufacture of steel by various methods. This department of the subject will be treated at considerable length.

Various Metals.—Platinum and its associated metals; cadmium;

sodium; aluminium; tungsten; titanium; manganese.

LIST OF SCIENCE SCHOOLS AND CLASSES.

Town.	Where held.	Teacher.	Secretary.	Sccretary's Address.	Total No. under In- struction in 1862–3.	Subjects taught and No. in each Class in 1862-3.
Aberdeen -	Mechanics Institution.	Prof. Brazier, Dr. Beveridge,	J. Sinclair -	Science School, Aberdeen.	66	15 Th. & Ap. Mec. 30 Chem.
Accrington -	do.	D. Maver. H. P. Meaden	H. G. Duffield	Christ Church Street, Ac-	19	27 Botany. 19 In. Chem. 14 Or. Chem.
Accrington -	New Jerusalem School.	H. P. Meaden	J. W. Kenyon	crington. Manchester Road,	25	25 Or. Chem.
Almondbury -	Central School	G. Jarmain -	Rev. L. Jones	Accrington. The Vicarage, Almondbury.	l 4	14 In. Chem. 8 Mineralogy.
Bacup	Mechanics In- stitution.	H. P. Meaden	J. Newbigging	Bacup	19	19 In. Chem.
Banbury -	British School -	J. H. Beale -	J. Cadbury -	Banbury -	58	9 Geology. 47 A. Phy.
Banbury -	Laboratory, 5,	T. Beesley -	J. Cadbury -	Banbury -	20	20 Zoology. 20 In. Chem.
Belfast	High Street. National Model	F. Eardley -	W. R. Molloy -	10 College Square	76	20 In. Chem. 10 Or. Chem. 20 Ex. Ph. 61 Chemistry.
Belfast	School. Museum	R. Tate -	J. T. Murphy -	East, Belfast. 13 College Square East, Belfast.	84	63 In. & Or. Chem. 11 Phy. & Zool. 47 Botany.
Birmingham -	Midland Insti- tute.	W. M. Williams	T. Martineau -	7 Cannon Street, Birmingham.	67	Ti Donay.
Birmingham -	School of Art -	D.W.Raimbach	C. Laundy -	20 Paradise Street, Birmingham.	31	31 Mec. Drawing.
Bolton	Bridge Street School.	T. Ward -	G. Knowles -	Tudor Villa, Heaton, near Bolton.	15	15 In. Chem.
Brinscombe - Bristol	Science School - Trade School -	W. Vick T. Coomber, W. Rowden, H. Fulton.	J. Beddus - J. Wilkson -	Brimscombe - Trade School, Bristol.	47 105	47 Chem. 61 Geo. Draw. 41 Mec. Draw. 21 Build. Con. 30 Th. Mec. 33 App. Mec. 71 In. Chem. 12 Or. Chem. 19 Geology.
Burnley	Mechanics Institution and Grammar School.	L. Clement -	J. Sutherland	Post Office, Burn- ley.	72	20 Mineralogy. 72 In. Chem. 16 Or. Chem.
Burnley	Church of Eng- land Literary Institution.	H. P. Meaden	B. W. Briggs -	North Parade, Burnley.	16	16 In. Chem. 2 Or. Chem.
Caine	Mechanics Institution and Middle School.	J. Bownas -	Rev. Canon Guthrie.	The Vicarage, Calne.	?40	40 In. Chem.
Camborne - Carrickfergus -	Parochial School House.	R. Tate -	W. Molony -	Union Hall, Car- rickfergus.	50	59 Geology. 50 Botany.
Chester - Chippingcam-den. Crewe	Boys School, Church Street.	W. Gunn -	Rev. J. Hamilton.	Campden, Glou- cester.	17	17 An. Phy.
Crow's Nest - Dedham - •	Literary Insti- tute.	J. C. Clough -	J. M. Rodwell	Dedham -	6	6 Chem.
Drogheda -	Mechanics Institute.	J. Dowling -	P. E. Grey	Drogheda -	44	32 In. Chem. 32 Or. Chem. 14 V. Phy. 14 S. Botany.
Dudley	Mechanics In- stitute.	J. Jones -	T. Wright -	Wellington Road, Dudley.	30	12 Metallurgy. 30 In. Chem.
Glasgow	Secular School	J. Mayer -	R. S. Cunliffe	21 Carlton Place, Glasgow.	102	26 Chem. 70 An. Phy. 52 Botany. 66 Metallurgy.
Glasgow	Andersonian University.		R. B. Smith -	39 Garnet Hill, Glasgow.	I	T
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Town.	Where held.	Teacher.	Secretary.	Secretary's Address.	Total No. under In- struction in 1862–3.	Subjects taught and No. in each Class in 1862-3.
Gloucester -	Blue Coat School	W. Jeffery	Rev. C. Crawley	Grey Friars, Gloucester.	35	35 Ac. L. & H. 24 Mag. & Elec. 24 Or. Chem.
Gunnis Lake - Halifax	Working Man's College.		G. Gibb	Haley Hill, Halifax.	35	34 In. Chem.
Haslingden -	The Institute ·-	H. P. Meaden	J. Binns -	Haslingden -	19	15 Mag. & Elec. 14 In. Chem. 12 Or. Chem.
Hastings -	Temperance Hall	T. Jones -	Rev. W. W. Hume.	Mary Magdalen's Parsonage, St. Leonards-on-	21	21 Geo. Draw.
Helston Hereford	Proprietary	S. Crawley -	R. M. Lingwood	Sea.	20	90 In. Chem.
Hollinwood -	School. National School	J. Mellor -	J. Fletcher -	Lyston Court, Hereford. Hollingwood -	24	20 In. Chem. 2 Or. Chem. 24 Geo. Draw. 24 Mec. Draw.
Huddersfield -	Literary and Scientific Institu- tion.	G. Jermain - G. Tindall -	G. W. Rhodes	80 Ramsden Street, Hud- dersfield.	Ter	24 Build. Const. 15 In. Chem. 9 Or. Chem. 9 Geology.
Kinver	Science School -	W. M. Packer	T. Bolton -	Hyde House, near Stourbridge.	10	11 Zool. 8 In. Chem. 2 An. Phys.
Leeds Lisburne	Mechanics Institution.	G. Ward	B. Blake and J. Pickering.	Mechanics Insti- tution, Leeds. Market Square,	32	3 An. Phys. 32 In. Chem.
Liskeard	Presbyterian School.	R. Tate -	J. Millar -	Market Square; Lisburn.	25	23 Zoology. 25 Botany.
Liverpool -	Free Library, William Brown junior.	Dr. Colling- wood. E. H. Birken- head. E. Bowen	J. Samuellson	Science School, William Brown Street, Liver- pool.	189	74 Ac. L. & Heat 74 Mag. & Elec. 23 In. Chem. 37 Geology. 37 Mineralogy.
London : BethnalGreen	Dirkhaak Sahaal	N. Samuelson		:		18 Zoology. 18 Botany.
Chancery Lane.	Birkbeck School London Mechanics Institution.	J. C. Douglas-	J. Pearsall -		62 50	43 Ex. Phys. 40 An. Phy. 50 Mag. & Elec. 50 Au. Phy.
Charterhouse Great Ormond Street.		A. Grugeon	G. Phillipson T. Shorter	45 Great Ormond	11	11 V. Phy.
Highgate -	Holly Lodge, West Hill.	M. C. Coote -	Rev. J. B. Dyne	Street. School House, Highgate, N.	19	11 S. Botany. 19 V. Phy.
Islington -	Public School, Lower Road.	J. Howard -	• • •	IIIgugaic, IV.	60	40 Ex. Phys. 24 Chem.
Poplar	Sailors' Home	W. Stockton - R. Strachan -			31	40 An. Phy. 6 Geo. Draw. 12 Th. Mec. 12 Ap. Mec.
Kingsland -	British School Room.	R. Bithell			58	6 Ac. I., & H. 6 Mag. & Elec. 6 In. Chem. 58 Geo. Draw.
	Birkbeck School	J. Rüntz	G. Bond -	3 Walcot Place, Hackney, N.E.	- 1	110 Ex. Phys. 110 Chem. 110 Phy. & Zool.
Lostwithiel - Macelesfield -	Modern Free School.	J. Chadwick -	J. Jackson -	97 Great King Street, Mac-		\$3 In. Chem.
				clesfield.	30	30 In. Chem.
	Christ Church School.	G. J. Suelus -	J. Brooker -	54 Mill Street,		
Macclesfield - Manchester -	School.	G. J. Suelus - J. Angell - J. Mellor -	J. Brooker - E. Simpson -	Macclesfield. Mechanics Institution, Manchester.	145	100 Geo: Draw. 45 An. Phy.

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Town.	Where held.	Teacher.	Secretary.	Secretary's Address.	Total No. under In- struction in 1862-3.	Subjects taught and No. in each Class in 1862-3.
Marazion - Margate	: -	-: · ·	J. Boulden -	Dane Hill House, Margate.		
Metropolitan see London. Middlesbro'		W. Crossley	W. Taylor -	Middlesbro' -	17	17 In. Chem.
Middleton -	Long Street -	G. W. Wheeler	Rev. J. W.	Middleton -	14	17 Or. Chem. 6 Ac. L. & H.
Nelston in Mars-	Mechanics In-	L. Clement -	Walker. J. Sutherland	Post Office, Burn-	15	12 Mag. & Elec. 15 In. Chem.
den. Netherton -	stitution. Mechanics In-	B. Bentley -	G. W. Rhodes	ley. 30 RamsdenStreet	12	12 In. Chem.
Northormesby	stitution. Class Room, Smeaton Lane.	R. Weatherill	Rev. V. A. Moyle.	Huddersfield. Northormesby, Middlesbro'-on-	10	10 In. Chem.
Nottingham -	Mechanics In- stitution.	Dr. T. Wilson	L. Liepman -	Tees. College Villa,	63	63 In. Chem.
Oldham	Parish Church Schools.	J. Mellor -	Rev. D. M. Alexander.	Nottingham. Oldham	95	95 Geo. Draw. 95 Mec. Draw. 95 Build. Con.
Padiham	Working Men's Trade Hall.	L. Clement -	J. Sutherland	Post Office, Burn- ley.	11	11 In. Chem.
Painswick -	Girls National School Rooms.	M. Pullen -	Rev. W. Moles- worth.	Painswick -	20	18 Mag. & Elec. 20 In. Chem.
Pendleton -	Mechanics In- atitution.	W. Hudson -	T. Gregory -	Victoria Park, Manchester.	. 18	13 Geo. Draw. 13 Mec. Draw. 13 Build. Con.
Queenshead -	National School	J. Halliday	G. Turner -	Queenshead, near Halifax.	18	13 In. Chem.
Rawtenstall -	Mechanics Institution.	H. P. Meaden	• • •		14	14 In. Chem.
Redruth St. Agnes -	-	C. Twite -	A. Paul -	Camborne -		
St. Ives	. :		•			•
St. Leonards -	Improvement So- ciety's Rooms.	T. Jones	Rev. W. W. Hume.	Mary Magdalen's Parsonage, St. Leonard's-on- Sea.	includ- ed with Hast- ings.	
St. Just Salford	Working Men's	C. O'Neil	W. Noare -	Town Hall, Sal-	18	18 In. Chem.
Slough	College. Mechanics In-	J.;Dorrell :-	J. Chapman -	ford. Upton Grove,	29	29 Geo. Draw.
Stockport -	stitution.	-W. Hudson -	T. Gregory -	Slough. Victoria Park, Manchester.	26	26 Geo. Draw. 26 Mec. Draw.
Stroud	Lecture Hall of Mutual Im- provement So-	M. Pullen - W. Vick - D. Paine -	S. T. Dudridge		` 88	26 Build. Con. 32 Chemistry. 27 Geology. 34 An. Phy.
Tandridge -	ciety. Club Room -	W. Brears -	Rev. A. S. O'Cal- laghan.	Oxted	15	12 Mag. & Elec. 15 Geology.
ravistock - ntwistle -	National School	W. Cooper -	P. Taylor	Tintwistle, Had- field, Manches- ter.	5	5 Th. Mec.;
lywardreath - Upton St. Leo- nards.	The School Room	W. J. Davies,-	Rev. J. Betts	Upton St. Leo- nards.	29	22 Mag. & Elec. 8 V. Phy.
Wednesbury -	Mechanics In- stitution.	John Jones -	C. T. Britten -	Wednesbury -	16	16 In. Chem.
Wigan	Mechanics Institution.	E. H. Birken- head.	M. W. Pearce	Wigan	51	87 In. Chem. 15 Geology. 14 Mining
Windsor • -	Working Man's Institute.	J. II. Hether- ington.	J. H. Pasmore	9 William Street, Windsor	21	21 Geo. Draw.
Wolverhampton	Christian Insti- tution.	John Jones -	J. N. Langley	Mowbry House, Wolverhampton.	15	15 In. Chem.
Foolwich -	Mechanics In- stitution Royal Arsenal.	Thos. Jones -	R. Mc'Grath -	Royal Gun Fac- tories, Wool- wich.	51	51 Geo. Draw. 55 Mec. Draw.
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TABLE of Honorary Diplomas granted without Examination.

Name,		Address.	o SE	Group I. Geometrical Drawing, &c.		Grou Mech Phy	Group II. Group III. Mechanical Experimental Physics.	Group III. Experimental Physics.	o III.	Group IV. Chemistry.	o IV.	Group V. Geology and Miner- alogy.	Þ. 89 ° °	Group IV. Group V. Group VI. Geology Animal sud Sud Miner- and Zoology.	77. 1. 28. 28. 28. 28. 28. 28. 28. 28. 28. 28	Group VII. Vegetable Physiology and Beconomic Botany.		Group VIII. Mining and Metallurgy,	VIII.
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Brazier, Professor	•	- Aberdeen -	:	·:	:	:	:	:	:	1st	1st	:	:	•	:	:	:	:	:
Collingwood, Dr.	•	- Liverpool -	:	:	:	:	:	:	:	:	:	:	:	1st	1st	1st	1st	:	:
Carter, B. B.	•	Strond, Glouces- tershire	:	:	:	:	:	:	:	:	:	:	:	1st	1st	:	:	:	:
Pepper, John H.	•	Polytechnic Insti- tute, Regent St., London	:	:	:	:	:	:	:	1st	1st	:	:	:	:	:	:	•	:
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TABLE Showing CERTIFICATES held by SCIENCE TEACHERS.

Revised by the Examination of November 1862.

The asterisk before a Name indicates that the Teacher was Certificated before the Minute of 2nd June 1859 came into operation.

		-	George Gr	Group I. Geometrical Drawing, &c.		Group II. Group III. Group IV. Group V. Group VI. Mechan. Experi. Glemis. Gleology Animal and Physical Physics. Hinge. Clemis. Miner. Gleoy and try.	HE GR	roup III. Experimental Physics.	8 5.	roup IV. Chemis-	Georgia Georgia	Group V. Geology and Miner-	Group VI. Animal Physi- ology and		Group VII. Group VIII Vegetable Physiology and Beone- and Beone- Metallurgy	VII.	Group VIII. Mining and and Metallurgy.	VIII.
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Abbott, Joseph Alldread, Edwin Allott, James Allen, William - Angell, John		Collegiate Institution, Liverpool Training College, Battersea National School, Ruabon, North Wales Grammar School, Moulton, near Spalding Mechanics' Institute, Manchester	:::::	::::	:::::	:::::		1st	1st 2nd 2nd 2nd 3rd	2nd d 2nd d 2nd	:::::	::::	 1st	:::::	::::	:::::	:::::	:::::
ard L.		Wilde's Endowed School, Lowestoff St. Martin's School, Leicester Laxton Street School, Leicester St. Mark's College, Cholsea 55, St. James Road, Holloway	:::::	:::::	::::	ist 3rd	73	3rd Srd	3rd 2nd 2nd 2nd 1st	d 2nd d 1st t 1st	:::::	:::::	:::::	:::::	:::::	:::::	:::::	:::::
Barret, E. Barlley, George C. T. Beale, John H. Beesley, Thomas Bentley, Buzi	'ei'''	31. Gloucester Street, Regent's Park Beresford Villa, Amherst Road, N. Schoel, School, Banbury 5, High Street, Banbury Kirkheaton	:::::	:::::	:::::	:::::		2nd 2nd 2nd 3rd	1 3rd 1 1st 1 1st	t 1st	2nd	:::::	:: 2nd ::	3rd	::::	::::	:::::	:::::
Beveridge, Robert *Birkenhead, R. H. Bithell, Richard	, , , ,	Training College, Battersea 2. Upperkirkgate, Aberdeen Mining School, Wigan Kingsland British School, Stoke Newing- ron Road, N.	:: 2nd	::::	::::	::::	<u>ــــــــــــــــــــــــــــــــــــ</u>	ist ist 2nd 2nd	2nd 2nd 1 1st	d 23.1	:: 1st	:: 2nd ::	ist 1st	:: 1st 1st	ist 2nd	:: ::	::::	:: 1st
Blackwell, C. A.	•	National School, Owston, nr. Bawtry	:	:	:	:	:	<u>:</u>	Srd	:	:	:	:	:	:	:	:	:
Blears, William Bocharoff, Alexis	•••	Training College, Westminster 17, Elton Street, Lower Broughton, Man- chester.	::	::	::	::	<u>::</u>	::	2nd 2nd	:: 55	::	::	::	:;	::	::	::	::

	Table showing Certificates held by Science Teachers-continued.	Certifica	stes he	ld by	Scien	ce Te	ache	8—cont	innec		::		· • :	:		:.
Name	Address.	Group I. Geometrical Drawing, &c.	rical F. &c.	Group II. Mechanical	p II.	Group III Experi- mental Physics.	H tax	Group II. Group III. Group IV. Group V. Geology Mechan- Experi- Chemis- Miner- Arysics. Physics.	₽ ₽ × ×	Geology and Miner- alogy.	Group.V Animal Physi- ology an Zoology	Group VI. Animal Physicology and Zoology.		Group VII. Vegetable Physiology and Economic Botany.	Group VIII. Mining and Metallurgy	VIII.
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Bowen, Edward	85, Boundary Lane, West Derby Road,	<u>:</u>	<u>:</u> .	:	:	Srd	3rd	: :	<u>:</u>	:	<u>:</u>	:	:	:	:	:
Bownas, John Breakwell, William	The Green, Calne, Wilts St. Mark's College, Chelsea	<u>::</u>	::	ist	::	::	::	2nd	<u>::</u>	::	::	<u>::</u>	::	::	::	::
Brears, William Briggs, James Alfred Bright, William	Tandridge School, Godstone, Surrey Mechanics' Institution, Chancery Lane - 17, Bute, Street, Cromwell Lane, Bromp-	:::	:::	:.:.:	:::	grd End	gnd Snd	s	:::	:::	:::	:::	:::	:::	:::	:::
Brown, Moses	Training College, Battersea Training College, Battersea	::	::	::	:.:	::	::	2nd	<u>::</u>	: :.:	::	::	:::	::	.::	:
*Burchill, Samuel H *Buckmaster, J. C. Burns, William Button, John Cattell, Thomas E.	Navigation School, Shadwell - St. John's Hill, Wandsworth s, Newton Terrace, Rochester Training College, Westminster National School, Cottesmore, Oakham	• • • • • • • • • • • • • • • • • • • •	:::::	1st ::	2nd 1st 	2nd 2nd 3nd	Srd Snd 	ist ist ist ist ist ist	:::::	:::::	:::::	:::::	:: Sind	:: \$ud	:::::	:::::
Causier, Jno. Wm Chadwick, John Chalk, Ellen M Chalk, Frank - Clapp, Elizabeth, M.A.	13, Hindon Street, Pimlico - Modern Free School, Macclesfield - 3, Heasman Terrace, Victoria Park 3, Heasman Terrace, Victoria Park, N.E. Birkbeck School, Kingsland	18t : : :	18t	3rd	::::	:::::	::::	:::::: .::::::::::::::::::::::::::::::	: % :::	:::::	:: 1st 2nd 2nd	:::::	:::::	:::::	:::::	::::
Clark, Albert Chas Clement, Leonard -	National School, Salisbury East Lancashire Union of Institutions,	::	::	::	::	ist	- Snd	3rd ist	2 2nd	::	::	::	ist .	::	::	::
Clough, James C Cockman, Abraham - Coles, Ferdinand -	Grammar School, Dedham	:::	:::	:::	:::	:::	:::	2nd 2nd 2nd 3rd	:::	:::	:::	:::	:::	:::	:::	:::
Collins, Joseph H.	Cathedral School, Manchester 86, Denmark Grove, Barnsbury Park	::	::	grd.	grd :	3rd :	::	3rd	3rd	<u>::</u>	2nd	<u>::</u>	::	::	::	::

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St. Anno's School, Wandsworth St. Anno's School, Parone Dancastes National School, Every Oxford National School, Every Carlet National School, Private Dancastes St. Mark's College, Batterses Training College, Batterses National School, Private Dancastes Training College, Batterses National School, Private Dancastes National School, Private Manchester Training College, Batterses National School, Private Manchester National School, Private Manchester National School, Preserved National School, Orleton National School, Orleton National School, Orleton National School, Desire Schools, Spiral Manchester National School, Leièseter National School, Briston National School, Briston, Briston, Oakhan National School, Briston, School, Hathield National School School, Briston, School,	:::	å : : : :	:::::	:::::	::::£	:::::	:::::	:::::
St. Anno & School, Wandaworth National School, Bedgoy, Oxnostee National School, Bedgoy, Oxnostee National School, Bristol Training College, Daterace National School, Thirtwistle, Manchester Training College, Batterace National School, Thirtwistle, Manchester Training College, Batterace National School, Thirtwistle, Manchester Training College, Batterace National School, Protect Training College, Batterace National School, Protect Training College, Batterace Training College, Batterace National School, College, College, College National School, Leicester National School, Read, Shough National School, Read, Shough National School, Leicester National School, Read, Shough National School, Read, National National School, Read, National National School, Read, National National School, Read, Shough National School, Read, National National School, School, Read, National National School, Read, National National School, School, Read, National National School, Read, National National School, School, School, Read, National National School, School, School, Read, National National School, Scho	:::	å : : : :	:::::	:::::	:::: 5	:::::	3rd 	:::::
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St. Anne's School, Wandsworth Broke's Station, Thomas, Doncates Broke's Station, Thomas, Doncates Brain Babool, Beckley, Oxfolse St. Mark's College, Chelses National School, Thinwistle, Manchester Training College, Batterses Training College, Westminster Training College, Mestminster Training College, Brited Training College, Mestminster Training College, School, Ripon St. Mark's College, Chelses Training College, School, Achiene Training College, School, Achiene Training College, School, Achiene Training College, School, Achiene Training College, School, Hatfield Tr	:::	:::::	:::::	:::::		:::::		:::::
St. Anno's School, Wandsworth Brookes School, Brate Doncaster National School, Beackey, Oxford Trade School, Brates Trade School, Filtrens, Doncaster Trade School, Filtrens, Doncaster Trade School, Filtrens, Cables Trade School, Filtrens Trade School,	::::		:::::	:::::		:::::	2: : : :	:::::
St. Anne's School, Wandsworth Brooks's School, Bristol Brooks's School, Bristol Trading School, Bristol Trading College, Chelsea National School, Westen Harewood, Leeds National School, Preferred Training College, Battersea Codmantherset, Hunts Codmantherset, School, Peckham Codmantherset, Spitalfields Buenos Ayres, South America National School, Orleton, Ludlow National School, Chelsea Trading College, Chelsea Trading College, Chelsea Traning College, Battersea St. Mark's College, Chelsea Traning College, Chelsea Traning College, Chelsea Traning College, Battersea St. Mark's College, Chelsea Traning College, Chelsea Traning College, Battersea Traning College, Chelsea Traning College, Battersea Traning College, Chelsea Traning College, Battersea Endows Brool, Bristol St. Mark's College, Chelsea Traning College, Whitechapel Balowed School, Exiton Marquis of Salisbury's School, Hatfield Wesleyan School, Skipn Wesleyan School, Skipn	<u> </u>					:: \$\$::	:::::	:::::
Bt. Anno's School, Wandsworth Brooke's School, Thorne, Doncaster National School, Bristol Training College, Chelsea National School, Bristol National School, Weeton Harewood, Leeds National School, Weeton Harewood, Leeds Codmanchester, Hunts National School, Hereford Freining College, Battersea National School, Weeton Harewood, Leeds Codmanchester, Hunts National School, Peckham Birkbeek School, Peckham Mechanics Institute, Middlesbroo School Oxt, Chester Upton St. Leonards, Gloucester Institute, Middlesbroo School Oxt, Chester Institution School, Spitalfields Buenos Ayres, South America National School, Orleton, Ludlow Wellington Road, Slough Wellington Road, Slough Wellington Road, Slough Wellington Road, Slough Upton Buckingham Street, Dublin County School, Leicester Training College, Chelsea Training College, Rayon St. Mark's College, Chelsea Training College, Rayon St. Mark's College, Chelsea Training School, Exton. Oakham Bolekow's Iron Workenwich Bolekow's School, Exton. Oakham Training College, Battersea Training School, Stron Marquiso Galsishury's School, Hatfield Wesleyan School, Exton. Oakham Marquiso Galsishury's School, Hatfield Wesleyan School, Schoy	3rd	Snd Srd Srd Snd	srd 2nd		8::: grd	. : : : : : : : : : : : : : : : : : : :	2nd :: 3rd	Srd
St. Anno's School, Wandsworth Brooke's School, Thorne, Donostee Brooke's School, Phorne, Donostee Brooke's School, Bristol Thade School, Bristol Training College, Battersea National School, Weeton Harewood, Leeds National School, Weeton Harewood, Leeds Oodmanchester, Humis Training College, Battersea National School, Weeton Harewood, Leeds Godmanchester, Humis Proprietary School, Preford Britcheck School, Prekham Britcheck School, Peckham Britcheck School, Leiester In Standmohury, Wolverron Days School, Leiester Wellington Road, Slough Wellington Road, Slough Britcheck School, Leiester Training College, Westminster Waterford St. Mark's College, Westminster Warring College, Westminster Training College, Britchel Britchew's Erreet, Greenwich Britchew's Stroet, Greenwich Britcher, School, Eristol Britcher, School, Eristol Britcher, School, Eristol Britcher, School, School, Haffield Westeran Westerand	::::	: : : : : : : : : : : : : : : : : : :	:::: E	Snd ::		::第::		i. gnd gnd
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Bt. Anno's School, Wandsworth Brooke's School, Brekley, Oxford f. Montacue Place, Kentish Town Trade School, Bristol St. Mark's College, Chelsea National School, Thrwistle, Manchester Training College, Battersea National School, Peckham Training College, Battersea National School, Weeton Harewood, Leeds Godmannbrester, Hunts Proprietary School, Hereford Birk beek School, Peckham Mechanics' Institute, Middlesboro' School of Art, Chester Upton St. Leonards, Gloucester Lipton St. Leonards, Slough Nellington Road, Slough County School, Leicester Training College, Westminster Training College, Westminster Training College, Westminster Training College, Westminster Training College, Battersea Lipton St. Mark's College, Chelsea Training College, Battersea Lindwerd School, Bristol Birdowed School, Bristol Birdowed School, Bristol Birdowed School, Bristol Birdowed School, Bristol Marquis of Salishbury's School, Hatfield Wesleyan School, Selby Wesleyan School, Selby		:::::	:::::	# ::::	:::::	:::::	:::::	:::::
Bt. Anno's School, Wandsworth Brooke's School, Thorns, Doncaster National School, Beckley, Oxford Trade School, Bristol R. Mark's College, Chelsea National School, Thirwistle, Manchester Training College, Battersea National School, Thirwistle, Manchester Training College, Battersea National School, Therwistle, Manchester Frouristary School, Peerson Birk beek School, Peerson Mechanics Institute, Middlesboro' School of Art, Chester Upton St. Leonards, Gloucester 127, Stanforboury, Wolverton Quaker Street Schools, Spitaifieds Buenos Ayres, South America National School, Orleton, Ludlow Mellington Road, Slough Wellington Road, Slough Wellington Road, Slough Waterford County School, Leicester Training College, Westminster Trade School, Ripon St. Mark's College, Chelsea Training College, Westminster Trade School, Bristol Training College, Battersea 22, Scarborough Street, Whitechapel Bindow's Iron Works, Middlesboro' St. Mark's College, Westminster Trade School, Bristol Training College, Battersea 22, Scarborough Street, Whitechapel Bindowed School, Exiton Marcuis of Salisbury's School, Hatfield Wesleyan School, School, Hatfield Wesleyan School, School, Hatfield	:£:	*****	:::::	# :::.	:: Sugard	1::::	:::::	::::
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Table showing Certificates held by Science Teachers-continued.

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Greenstreet, Wm. A Greenwood, Aaron T. Grove, John W. Grugeon, Alfred Gunn, Willian	Christ Church School, Chelsea Training College, Westminster Green-coat School, Hertford 3, Radnor Terrace, Brownlow Rd., Dalston Chipping Campden, Gloucestershire	::::	:::::	:::::	3rd	:::::	:: %:::	3rd 3rd 	:::::	;::::	:::::	 2nd	2nd	2 pug	 2nd	::.::	:::::
Haigh, Thomas R Haliday, John - Hands, Jonathan G. Hancock, John - Hargreaves, John -	Training College, Westminster Queenbury Schools, near Halifax Training College, Battersea IT, Riding House Street, Langham Place National School, Goldsboro', Knaresboro'	:::::	:::::	:::::	:::::	: 3rd	l 2nd	3rd 3rd 3rd 2rd	:: :: 2nd	:::::	::::	:::::	;::::	:::::	· :::::	:::::	:::::
Hetherington, J. H. High, William E. Hofchkin, Tycho E Holt, George - Holdcroft, Herbert -	Windsor Road, Slough Blue Coat School, Cirencester 9, Ashwell Street, Leicester Wesleyan Traning College, Westminster Training College, Westminster	其::::	:::::	:::::	:::::	:::::	:::::	3rd 1st 2nd 3rd	3rd 18t	:::::	::::	:::::	:::::	:::::	:::::	:::::	:::::
Hough, Robert -	Cowper House School, Huntingdon Wrottersley Observatory, near Wolver-	::	::	::	.: 3rd	::	::	3rd	::	::	::	1st	::	::	::	::	::
Howard, John - Hudson, Fearnside - Hudson, Washington	Lower Eington Public School, London 68, Corporation Street, Manchester Earle Foundry, Manchester	Sud	 2nd	2nd	:::	gnd :	3rd :	: 1st	: 1st	:::	:::	2md ::	2nd	.: ::	2nd	:::	:::
Hudson, J. Schoffeld Hudson, William - Hurst, Wm. F Ives, Wm. Field - Jackson, Robert -	National School, Brenkburn-morpeth National School, Abedellery near Newport Middle School, Leicester St. John's School, Limebouse St. Mark's College, Chelsea	:::::	:::::	:::::	and and	ist	::: 18t	3rd Srd 2nd	:::;;	:::::	::::;	:::::	:::::	:::::	:::::	:::::	:::::
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Jackson, William Jarmain, George Jeffroy, Walter Johnston, Wallam Jones, Rdward Jones, Jones, John Jones, Thomas Judd, John W. Kerby, Isaac		Hunsingore, near Wetherby East Parade, Huddersfield Blue-cont Hospital, Gloucester Ini, Perry Street, Newcastle-on-Tyne Training College, Westminster St. Thomas Charterhouse Schools The Trindle, Duddey 2. Brixton Rise, Brixton Hill, London St. Mary's School, Putney Training College, Westminster	:::::::::::::::::::::::::::::::::::::::	:::::::::::::::::::::::::::::::::::::::	:::::::::::::::::::::::::::::::::::::::			srd 3rd 3rd 3rd 3rd 3rd	3rd 18t 18t 2nd 18t 3rd	11st Sard Sard Sard Sard Sard	1st	ist 3rd 2nd 3rd 1st	::::::::::::::::::::::::::::::::::::::		::::: :::::::::::::::::::::::::::::::::	ist End		:::::::::::::::::::::::::::::::::::::::	
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Longbottom, Josiah Mc Callem, James McFarlane, Archibald Mackrell, Isaac		Valuet, Salono,, voorge town. Wesleyan College, Westminster Railway Workshops, Kilmarnock Bast Hardwick, Pontefract Wesleyan College, Westminster	: :	:::::	:::::	:::::	::::	: : : : :	:::::	g:: Sud	: : : : :	:::::	:::::	:::::	:::::		:::¤:		:::s:
Macomish, Margaret Manser, William Marshall, John E. Martin, William Mason, James		39, Gloucester Street, Glasgow Training College, Battersea St. Thomas 'Charterhouse Schools Woodhill School, Hatfield 100, Upper Thanes Street, E.C.	:::::	:::::	:::::	:::::	:::::	:::::	:::::	and Srd 1st	1::::	3rd	:::::	13t : : : :	:::::		:::::	:::::	
Mayer, David Mayer, John *McIvor, Alexander Meaden, Henry P Mellor, James		Mechanics' Institute, Aberdeen Secular Selbol, Carlton Place, Glascow Canongate Burgh School, Edinburgh George Street, Haslingden Science School, Oldham	::: : : : : : : : : : : : : : : : : :		2	Srd ::	:::::	13t 18t	ist 2nd 	żnd żnd	2nd 2nd	:::::	:::::	: is:	:::::		::: 1st	1st 2nd	
Merrifield, John Millican, William Moore, Thomas Moss, Amos Morton, George H.	1111	St. Mary Tavy, Tavistock Training College, Westminster Training College, Battersea St. Mark's College, Chelsea 7, London Road, Liverpool	:::::	:::::	:::::	:::::	:::::	:::::	:::::	Sugarda :	2nd 	::::ts	:::::	:::::	:::::		:::::	:::::	
Nelson, Robert J. Nicholson, William Noble, John Northey, John		Navigation School, Shadwell Camborne House, Ventnor, Isle of Wight - Working Man's College, Halifar - 15, Salisbury Street, Lisson Grove -	::::	::::	::::	2nd	3rd 	žnd 	ist 1st	:: lst 2nd	ist 2nd	::0	::::	::::	::::		Bud ::	3:	

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	Мате.	•		O'Neill, Charles Orkney, Daniel	Packer, Matthew Pascoe, John Patchett, Isaac - Pearce, Richard	Pearco, William Pearsall, T. J. Pepper, Charles Perry, George W Phillips, Harvey	Pike, Robert W. Pitt, Robert Plant, John Pullen, Moses Puckett, Joseph	Radford, Arthur' Raimbach, David Redgrave, Gilber Ricks, George	Robertson, John Robertson, John
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Rüntz, James - Rushforth, Thomas -	Bluecoat School, Wolverhampton - St. John's School, Woking, Surrey	::	::	::	::	::	and	::	3rd	::	::	=======================================	18t .	::	::	::	::	::
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Sarjeant, John Sapinan, Zebedee Schoffed, Jaher C. Sebander, Jaher C. Seaman, Lease Se	Ofmuch Street. Stoneh Navigation School, Hull St. Mark's College, Chelsea. Ils, Cumming Street, Pentonyille Wedlevan Training College, Westminster		::::::	· ; ; ; ; ;	s.:	2 and	: :: ; ; ;		Srd	: :::::					:;;::::	::::::	::::::	: : : : : :
Sharp, Charles J. Shaw, Henry Chas. Shawaros, William Sheaf, Robert Shinn, Thomas	16a. Upper North Place, Gray's Inn Road National School, Falmouth, Northwood School, Stokeon, Trent Highfield School, Southampton Queen's Printing Office, B.C.	::::::	::::::			.::::	1::::			g::	: -			:::::	‡ ; ; ; ;	:::::	:::::	:::::
Shirley, James Shore, Thomas W. Simpson, Bentham Smeeth, Rowland Smith, Joseph H. T.	St. Mark's College, Chalses - Church of England School, Churcham, near Gloucester. St. Matthew's School, Bethnal Green National Model School, Befrast St. Thomas' Charterhouse Schools	::::::	. : : : : :	::::::	2nd	2nd	End ::	2nd ::	ង : :::	:: :::	2nd 3	::	. : : : : : : : : : : : : : : : : : : :	::::::	.;; :;:	::::::	::::::	:::::
Smithies, Samuel Snelus, George 4. Spencer, James. Spink, John Stirrup, Thomas	Training College, Westminster Christ Church School, Macclessfield IT, New Street, Charles Town, Halifax Cathedral School, Kipon National School, Stockport, Cheshire	:::::	: :::	· : : : : :	3rd 2nd	s.	:;:;:	:::::	Znd Znd	: srd : 3rd : 3rd	2		-:::::	:;:::	• ; ; ; ; ;	:::::	:::::	:::::
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Taylor, Charles Thackrah, Samuel Tindall, George Tomkins, Samuel Tribe, Alfred	St. Mark's College. Chelsen - Grove Street, Huddersfield Frampton Cotterill, Bristol - 12, Westbourne Grove, North	:::::	::::	:::::	::: !st	:::::	:::::	:::::	2nd		:::£:	:::::	18t	.: 1st	:::::	:::::	::::	:::::
Trower, Bichard Turner, George Turner, S. C	55, New England Street, Brighton National School, Queenshead, Halifax - 4, Marlbro' Terrace, Victoria Road, W.	:::	:::	:::	3rd	:::	Sud :	2nd 3	ቹ : :	:::	2nd		:::		:::	:::	:::	:::

Table showing Certificates held by Science Teachers—continued.

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Name.		Address.	Ged	Geometrical Drawing, &c.	cal &c.	Mechan- ical Physics.	han- al sics.	Experi- mental Physics.	eri- ntal sics.	Chemis- try.	try.	Geology and Miner- alogy.		Animal Physi- ology and Zoology.	si- si- snd	Vegetable Physiology and Econo- mic Botany.	sble ology cono- stany.	Mining and Metallurgy.	ing d urgy.
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Twite, Charles - Vick, William -	• •	Miners' Association, Truro - National School, Cameross, Stroud	::	::	::	::	2nd	puz	pug	3rd 3rd	3rd	3rd 2	2nd	::	::	::	::	gud :	::
Waite, John - Ward, Thomas - Ward, George - Warner, William Watkins, James		Darley Street School, Leeds Wesleyan S., Bridge Street, Bolton Mechanics Institution, Leeds Training College, Battersea Grammar School, Deptford	::::	:::::	:::::	:::::	::::	:::s::	:::::	Sud Sud Sud Sud Sud	3rd	Sind	:::::	:::::	:::::	:::::	:::::	:::::	:::::
Weatherill, Robert	ť	Pennyman School, North Ormesby, Mid-	:	:	:	:	:	:	:	3rd	2nd	<u>:</u>	<u>:</u> :	<u>:</u>	<u> </u>	:	:	:	:
Wheeler, G. H. Wild, Robert - Williams, John Williams, W. M.	• • • •	ucsonor-in-reser. National School, Middleton, Manchester-strong Shatonal School, Promiery, Middlesex St. Mark's College, Chelsea Oak Alyn, near Wrexham, Denbighshire	::::	::::	::::	: :st ::	::::	1st ::	1st :: 1st	3rd 2nd 	 2nd	::::	51	2nd 	::::	gud	::::	::::	:::
Wilson, Thomas Winney, William Winter, William Wire, Alfred P.		Derby Road, Nottingham Training College, Westminster Training College, Westminster Training College, Battersea Pharmaceutical Society, Bloomsbury Sq.	:::::	:::::	:::::	:::::	:::::	3rd :::	:::::	3rd 3rd 1st 1st	srd ist	:::::	:::::	:::::	:::::	:::::	:::::	:::::	:::
Wood, Charles S. Wood, Edward - Woodcock, Fred.W. Woodhead, William Woodward, Chas. J.	¥.a⊢	New Zealand 31. Richmond Place, Brighton Grammar School, Boxworth 166. Wavertree Road, Edgehili, Liverpool Midland Institution, Birmingham	:: 5ug	:::::	:::::	2nd 	:::::	:::::	:::::	1st 2nd 1st 1st	2nd 3rd 1st	1st	1st	2 :: :	:: Sind	žnd 	znd 	1st	
Woollett, John .	•	3, Millfield Place, Green Lanes, Stoke	:	:	:	:	:	:	:	3rd	:	:	<u>:</u> :	· :	:	:	:	:	:
fates, Frederick	•	Pennfields, Wolverhampton	:	:	:	:	:	:	:	:	:	:	<u>-</u>	lst .	:	:	:	:	:
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SCIENCE AND ART DEPARTMENT OF THE COMMITTEE OF COUNCIL ON EDUCATION, South Kensington.

DIRECTORY,

(Revised to Sept. 1864.)

WITH

REGULATIONS

FOR

ESTABLISHING AND CONDUCTING

SCIENCE SCHOOLS & CLASSES.

THE RULES IN THE PRESENT EDITION SUPERSEDE THOSE IN ALL FORMER EDITIONS, BUT ARE ALWAYS SUBJECT TO REVISION.



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1864.

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SCIENCE AND ART DEPARTMENT OF THE COMMITTEE OF COUNCIL ON EDUCATION.

CROMWELL ROAD, SOUTH KENSINGTON.

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v. 1; vt. 1.; A. 2nd grade; J. B. Rundell.

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* The letters S and A refer to the Science and Art Certificates taken.

SUMMARY of the NATURE and Amount of Assistance afforded by the Science and Art Department to the Industrial Classes in procuring Instruction in Science.

[Important Alterations made since the last addition of the Directory are printed in Italics.]

- I. A sum of money is voted annually by Parliament for scientific instruction in the United Kingdom.
- II. This sum is administered by the Science and Art Department.
- III. The head of the Education Department of which the Science and Art Department is a branch is the Lord President of the Council, assisted by a member of the Privy Council, who is called the Vice-President of the Committee on Education, and who acts under the direction of the Lord President, and for him in his absence. (Order in Council, 25th February 1856, Act 19 & 20 Vict. c. 116.)
- IV. The object of the grant is to promote instruction in Science especially among the industrial classes,* by affording a limited and partial aid or stimulus towards the founding and maintenance of Science schools and classes,†
- V. The payment of fees by the students Fees by can be looked upon as the only solid and Students. sufficient basis on which a self-supporting system can be established and supported. Though my Lords do not consider it necessary at present to lay down any rules making the payment of fees an absolute condition of the grants on account of Science

Direct payments are made to teachers only on behalf of adult artisans, or the children of artisans, or the children of persons who are not assessed to the income tax, or who do not possess an income of 100l. a year. (See § xiii.)

[†] The amount is liable to be decreased and eventually withdrawn. Payments to teachers therefore must not be looked upon as perpetual, or in any way conferring on the teacher a claim to any payments beyond those offered for each current year.

instruction, yet as the payments from the State must be expected to diminish, and as aid on account of those persons who do nothing for themselves cannot be justified, Committees of schools and classes, and Teachers, are strongly urged (should it at present not be the practice) at once to impose as high a scale of fees as they consider can be raised not only on middle class students but also on artisans.

VI. The following are the Sciences towards instruction in which aid is given:—

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Subject	: 1,	Practical		and	Des	criptive
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"	1,	Mining.				ing ing s
"	2,	Metallurgy			_	_
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VII. The assistance granted by the Science and Art Department is in the form of—

1. Payments on results to certificated teachers. (See § xv., xviii., xix., xx., and xxi.)

2. Grants towards the purchase of apparatus, &c.

(See § xxiii.)

3. Public examinations in which Queen's Medals, Honorary Certificates, and Prizes are awarded, held at all places complying with certain conditions. (See § xi., xii., xiii., xiv., xv., xvi., and xvii.) On the results of these examinations the payments are made to the teachers. (See § xv., xviii., xix., and xx.)

VIII. Examinations for certificates to Examinations teach any of the before-mentioned sciences Certificates. are held annually, commencing in the first week in November, at South Kensington. Examinations will also be held in Dublin and Edinburgh if five candidates register themselves for examination in Ireland and in Scotland. Any person whatever may attend this examination by sending in his name to the Secretary of the Science and Art Department, before the 15th October, stating the subject or subjects in which he wishes to be examined. ficates of three grades are given in each group and each subject. These certificates are only considered as simple records of the results of examination in the various sciences before mentioned, entitling the teacher to earn payments by successful teaching in the subjects for which he is certificated.

IX. Suitable premises, with firing, light-ing, &c., must be found and maintained at the cost of the locality where the school or class is held. If at any time the funds do not cover these requisite local expenses, it must be inferred that there is no such demand as the Government is justified in aiding, for instruction in the locality; and the assistance of the Department will be withdrawn.

X. A Local Committee of not less Local Committee.

than five well known responsible persons

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must be formed in connexion with every Science Class, who will carry out the instructions contained in Appendix. See pages 15 to 18.

XI. The Science and Art Depart-Examination of Classes ment holds, through the agency of each under Cer-Local Committee, in May of each year, a public examination of all Science schools and classes in any locality throughout the United Kingdom which complies with the requisite conditions. (See § x, xiii., and xiv.) On the results of this examination the payments are made to certificated teachers. (See § xv., xviii., xix., and xx.) Application for it must be made (on Science Form No. 119. See page 19, which will be sent on application) to the Secretary of the Science and Art Department before the end of March in each year, stating the number of persons and the subject or subjects in which they are to be examined.

All registered Students of Science Classes under certificated teachers (except Science certificated teachers) are eligible to receive Queen's prizes and Queen's medals under the conditions hereafter mentioned.

(See § xv., xvi., and xvii.)

Examination of other Classes.

A teacher not holding a certificate, may, by applying to the Secretary of the Science and Art Department, be examined at the same time and in the same manner as the classes under certificated teachers; provided that a Local Committee be formed which complies with the requisite conditions. (See Appendix, pages 15 to 18, Science Form, No. 88 a.)

If the class be for artisans the pupils are eligible to receive Queen's Prizes and Queen's Medals under the same condition as the pupils of certificated teachers. Should it however be for the middle classes the pupils are not eligible for prizes and medals, but receive certificates of merit instead.

XIII. If two or more classes in the same Places of town, or within a reasonable distance of Examination. one another, apply for the examination of the Science and Art Department, a general examination committee must be formed by the amalgamation of the several Committees to carry out the examinations at some common centre, such as the town hall or other public building. It is only when the classes consist of 100 or more candidates that such amalgamation of the committees will not be insisted on at present.

XIV. Any persons whatever, whether Examination taught by the certificated teacher or not, Students. may present themselves at the Local Committee's examination on registering their names in time for the Local Committee to comply with the instructions, and paying a registration fee of not more than 2s. 6d. each. Arrangements must therefore be made by the Local Committee, or the general examination committee, as the case may be, to enable other candidates, besides the students in the class for which the Committee act, to present themselves at this examination. The registration fee of 2s. 6d., which such candidates may be required to pay, is to reimburse the Committee for any extra expenses incurred by such attendance, and may at their option be remitted.

These candidates, if artisans, are eligible to receive Queen's prizes and certificates of merit (see § xvi. and xviii.); if registered students in artisan classes, they are eligible to receive Queen's medals, Queen's prizes, and certificates of merit under the conditions mentioned in § xvi. and xvii.; and if middle class

students to receive certificates of merit.

XV. The results of the May exami- Classification nation are classified under the following heads:—(1) first class, (2) second class, (3) third class, (4) honourable mention, (5) pass, and (6) The names of the successful candidates, those under the first five heads, are published.

standard of attainment required may be raised from year to year. For the Pass it is only such as will justify the Examiner in reporting that the instruction has been sound, and that the students have benefited by it. Those who have attained a higher degree of proficiency are classed as honourable mention, or as 3rd, 2nd, or 1st class, according to their merit.

Queen's Prizes. XVI. To the 1st, 2nd, and 3rd class are given Queen's prizes consisting of books or instruments chosen by the candidates from lists furnished for that purpose. These are unlimited in number, except that a student who has once received a 1st, 2nd, or 3rd class Queen's prize cannot receive the same or a lower class prize in the same subject again. If such student should be again successful, his name will simply be recorded in the published list. (See the conditions to § xi, xii., and xiv.)

Queen's XVII. The Queen's medals are—one gold in each group, one silver, and two bronze in each subject for competition throughout the United Kingdom.

Only registered students of schools and classes under Local Committees (see § xi. and xii.) can obtain medals. They cannot be taken by middle class students who are more than 17 years of age. Students who but for this restriction would have taken the medal, will receive an honorary certificate instead. Should a student take more than one gold, silver, or bronze medal, he will receive books instead of a second medal.

Payments to Teachers. XVIII. Payments are made to the certificated teacher in those subjects in which he is certificated on the following scale:—11. for every student of the industrial classes who passes in each subject; 21. for every one who obtains an honourable mention; 31., 41., or 51. for every one who obtains a 3rd, 2nd, or 1st class Queen's prize;

provided that such student has received 25° tessons at least from the certificated teacher in each subject since the last examination, each lesson being an attendance at a meeting of the school of at least three quarters of an hour duration on a separate evening.

The 30 lessons need not necessarily be all given in one year, but may extend over a longer period. 5l. is the maximum that can ever be claimed on account of the instruction of any one pupil in a subject, and this, only, subject to the reductions entailed by § xix. and xx. That is to say, for a pupil taking a 1st class for whom at a previous examination the teacher received 3l. for a 3rd class, he can only claim 2l. If the same pupil had previously taken a 2nd class the teacher could only claim 1l. on his account, and so on.

XIX. If a student be successful at the examination in more than one subject, the teacher can only claim half of the above payments in respect of such further subject in which he is successful.

XX. Payments are only made on the foregoing scale when they amount to not more than 60l. When on this scale they would amount to more than 60l. the excess up to 40l. is diminished by one quarter, the excess above 40l. by one half. Thus payments which on the above scale would be 100l. and 150l. will be reduced to 90l. and 115l. respectively.

XXI. The claim of a master for the Form of Claim payments under these several heads is made on Science Form No. 51, which will be sent

† Thus, 100, that is 60+40, is reduced to $60+40-\frac{1}{4}$ of 40 = 60+30=90. 150, that is, 60+40+50 is reduced to 60+30+25=115.

^{*} It must be clearly understood that the number (25) of lessons which the teacher is required to give is the minimum fixed as a criterion that the pupil has received his instruction from the teacher, and is not meant in any way to specify that that amount of instruction is sufficient, or to guarantee the teacher's receiving payment, if that amount of instruction alone is given.

on application. The voucher must be signed by the secretary and two members of the committee of the science class or school; or by at least three of the committee. (See Appendix, page 21.)

School Register. XXII. A school register must be kept on a form which will be supplied on application. This must be made up from day to day, and will be examined and approved by the Inspector on his visit. It must be sent to the Department with the teacher's claim for payment, and no payment can be made unless it is properly kept.

AXIII. A grant towards the purchase of apparatus, diagrams, &c., of 50 per cent. on the cost of them, is made to science schools and classes in Mechanics' and similar institutions where the teacher is certificated, and to the extent of 51. to other poor schools and classes. A requisition must in these cases be made on Science Form, No. 49. (See page 25.)

Travelling Expenses of Teachers.

XXIV. The travelling expenses (second-class railway fare, and 10s. per diem personal allowance) of a candidate in attending the November examination are paid if he be successful in taking a certificate or in improving the grade of one he has already taken, provided the candidate is bonâ fide engaged in tuition, or is preparing for tuition.

Instruction in an Elementary School.

XXV. All payments to certificated teachers on account of Science teaching are made by the Science and Art Department, and are only made in respect of a school in connexion with the Science and Art Department. They do not apply to any instruction in Science that may be given during the three attendances of an Elementary School receiving aid from the Education Department, Whitehall.

XXVI. These grants are only made while the teacher is giving instruction school in a day or evening school or class for the industrial classes (adults or boys), approved by the Science and Art Department, and open at any time to the visit and inspection of its officers. The Managers of an Elementary School under the inspection of the Education Department can permit such part or parts of their premises to be used for Science teaching as shall not interfere in any way with the three attendances of the Elementary School.

XXVII. The certificated teacher of Master with an elementary school receiving aid from the Educational Department, Whitehall, who has pupil-teachers to teach cannot receive payments on account of Science teaching, even if holding a Science certificate.

XXVIII. But certificated teachers Masters without of elementary schools receiving aid from the Educational Department who have not pupilteachers to teach have their time out of schoolhours at their own disposal, so far as official regulations are concerned, and may if further certificated in Science give scientific instruction under the Science and Art Department.

APPENDIX

EXHIBITIONS, SCHOLARSHIPS, AND PRIZES, AT THE ROYAL SCHOOL OF MINES.

At the May 1865 examination three of the following Royal Exhibitions and Free Admissions to the Royal School of Mines will be open for competition independent of the prizes, &c. offered by the Science and Art Department.

ROYAL EXHIBITIONS.

1. Eight Royal Exhibitions of the value of 501. each per annum entitling the holders to free admissions to all the lectures, and the Chemical and Metallurgical Laboratories at the Royal School of Mines, to be held from year to year for three years, on the condition that the holder attends the lectures and passes the examinations required for the associateship of the School.

The competition for the Royal Exhibitions will be determined by affixing the following values to the several results of the May examination, viz.:—

To a 1st grade Queen's Prize, in an	y subject	• .	-	9 marl
To a 2nd , ,	· ,, · · · ·	• 1.0	•	7 "
To a 3rd "	**	•·	2	5
To an honourable mention	29	•	-	5 ,,
To a pass	. **	•	•	1 ,,
. 3.3111	-			. , 1

and in addition-

For a gold medal For a silver medal For a bronze medal

N.B.—Science Certificated Teachers may compete for the Royal Exhibitions.

FREE Admissions.

2. Free admissions to the lectures at the School of Mines.

A free admission is granted to any person who takes a gold medal in the May examination.

There are, in addition, the following Scholarships attached to the School—

HIS ROYAL HIGHNESS THE DUKE OF CORNWALL'S SCHOLARSHIPS.

His Royal Highness the Prince of Wales, as Duke of Cornwall, has granted two scholarships of 30l. each. One becomes vacant every year, and will be competed for by those students only who have passed the examinations of the first two years of the curriculum required for associates. It is held for two years by the successful competitor.

ROYAL SCHOLARSHIPS.

Two scholarships of 151. each are given to the students who shall stand highest on the list of those who have passed their examinations for the first year—and a scholarship of 251. to that pupil, not being the Duke of Cornwall's scholar, who passes the best examinations after the end of the second year. These scholarships will be granted to those students only who have obtained first-class places in the examinations

of their year, or in those of at least two of the Professors in the case of such students as take the two first years in one.

For further particulars see prospectus of the "Royal School of Mines," to be had on application at the Museum in Jermyn Street.

SCIENCE FORM, No. 88.

LOCAL COMMITTEES FOR SCIENCE SCHOOLS AND CLASSES.

- 1. A Local Committee of not less than five well-known responsible persons must be formed in connexion with every Science class, in order to comply with the necessary requirements of the Science and Art Department, and to carry out various arrangements on its behalf necessary for testing the efficiency of the science instruction, on the proof of which alone the aid of the Department is given.
- 2. The gentlemen proposed to act on this Committee are to fill in the form on the next page, stating their willingness to carry out the necessary arrangements for examinations, &c., and giving the address and occupation of each member.
- 3. The relation of the Committee to the teacher of a Science school or class will vary much according to the varying circumstances of different localities. In some places where the demand for science instruction is great, and there is an energetic local teacher to take advantage of it, the chief duty of the Local Committee may be to give the teacher the necessary vouchers for obtaining his payments. While in other places, where those who take an interest in and wish to further science instruction may, with that object, subscribe to and establish scientific classes either in connexion with an existing institution or not, and may engage a teacher certificated in science to instruct the classes, the teacher must, to a great extent, be the paid officer of the Committee. With these local arrangements the Science and Art Department does not interfere, but leaves them to the locality to settle. The local circumstances will determine whether, as in the first case, the master receiving the whole of the fees for instruction should provide at his risk the room for instruction, with the necessary firing, lighting, &c., or what, as in the second case, should be the proportion of the fees deducted on this account by the Committee.
- 4. The Science and Art Department requires that the Local Committee shall—

Be responsible for the safe custody of all apparatus towards the purchase of which the Department has paid 50 per cent.

b. That they shall provide a room or rooms of sufficient size to carry out the annual examination according to the detailed regulations under that head. This examination is of all persons who wish to present themselves, and not only of those taught by the certificated teacher; but those persons who are not taught by the certificated teacher must send in their names before the 1st March, and may be required to pay a registration fee of 2s. 6d. for the whole examination.

- c. That a school register, showing the attendance, number of lessons, payment of fees, &c., on an approved form, be kept properly filled up, and sent to the Science and Art Department when required.
- d. That they shall send in to the Secretary of the Science and Art Department the list of students to be examined, before the end of March, specifying the subjects in which they are to be examined. That they shall be responsible for conducting and superintending the examination: giving out the examination papers which will be sent for that purpose: seeing them worked fairly and certifying to the same, not less than three of the Committee being always present: and sending the worked papers, under seal, by the day's post to the Secretary of the Science and Art Department.
- e. That they shall certify, firstly, that those students on whose examination the teacher bases his claim to payments on results, are artizans or operatives, or their children, or can claim as such (see Science Form, No. 51); and, secondly, that they have received 40 lessons at least from the teacher in the year or since the last examination, on their passing at which payment was claimed on their account.
- 5. The Science school or class must be at all times open to the visit and inspection of the officers of the Science and Art Department as a condition to the grant of aid from it; if at any time it is found that the apparatus, &c., towards the purchase of which a grant has been made is not properly taken care of, or that a proper room with firing, lighting, &c., is not provided for the class, the aid of the Department will be withdrawn.

Note.—As it is to the Committee that the Department looks to carry out the great proportion of the duties of the school, as many as possible of the members of the Committee should attend on the inspector's visit.

FORM of APPLICATION to act as a COMMITTEE for a Science School or Class. We the undersigned.

[1. The Committee shall be composed entirely of well-known responsible persons of position who are quite independent of the school or class, and who have no such personal interest in it as can lay them open to the slightest suspicion of partiality; and of course no member should be connected with the Teacher, have any pupils for examination, or be a pupil himself.

2. It is very desirable that as many persons as possible in recognized positions of public responsibility in the district, such as Magistrates, Municipal Authorities (Mayor, Aldermen, or Town Councillors), Head of Educational Establishments (Trustees of Grammar Schools, Managers of National Schools), Clergymen, &c., should be on the Committee.
3. It is absolutely necessary that at least two such responsible persons should

agree to act.
4. The Committee must consist of a Chairman, Secretary, and at least three other Members.

Members.

5. The Chairman must be a Magistrate, Mayor, Boroughreeve, Provost, or Alderman, or other public officer of recognized position, Trustee of Grammar School, or Clergyman of the Established Church in parochial employment.

6. The Chairman of the Committee will inform My Lords as to the constitution of the Committee being in accordance with these requirements.

7. The Secretary of the Committee of the Science School or Class, as being the medium of communication, will carry on all correspondence with the Science and Art Department, and is held responsible for making out and sending all returns required, for the receipt and distribution of the examination papers, the transmission of the worked papers, &c., at the proper times according to the regulations; and in consequence of the necessary demands on his time and trouble My Lords have sanctioned, provisionally, the payment to him of the following fees:—3l. for the duties connected with any Science school or class consisting of 5 or more pupils which is examined and 1l. in addition

for each further day's examination held. The Secretary must be a member of the Committee; the requirements in par. 1 apply equally to bim.

8. This form is to be filled in and returned to the Department annually before the 15th December, except in the case of new schools or classes, when it should be made as soon as they are formed.]

propose to act as the	Local Committee for the	ne Science Class held at
and taught by		
We undertake for the year satisfactory to the Sci	r at least, and fur ience and Art Department	ther till another Committee has been appointed.
		all the Apparatus, Dia- he Department has in any
to be present at, Class according to	and superintend, the exa	eady at the appointed time minations of the Science Science and Art Depart- chers.
such examination, sufficient space for	according to the rules of t the examination, not only	r the due carrying out of he Department, providing y of all persons taught by o may wish to attend the
any extra expenses the 4. That the School	iey may be put to in providin	any time to the visit and
		1 .
SIGNATURE.	Address.	OCCUPATION.
Chairman.	·	
Secretary.		
I certify that this Con 1, 2, 3, 4, and 5.	nmittee complies with the	requirements of the rules
•		Chairman.
The Secretary, Science and A	rt Department.	
	d on application to the S	ecretary, Science and Art

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SCIENCE FORM, No. 88 a.

South Kensington, August 1863.

LOCAL COMMITTEES FOR SCIENCE SCHOOLS AND CLASSES NOT RECEIVING AID FROM BUT EXAMINED BY THE SCIENCE AND ART DEPARTMENT.

This Form is a modification of the previous, No. 88., and may be had on application to the Secretary, Science and Art Department, South Kensington,

SCIENCE FORM, No. 120.

South Kensington, December 1863.

SCIENCE CLASSES UNDER CERTIFICATED TEACHERS.

Annual Report of Science School or Class,

To be made on its establishment, and annually (before the 1st January) of its

continuation.

lace, as Mechanics' Institution	1, &c., in	which th	e Classes	
Name of Street, No., &c		· · · · · · · · · · · · · · · · · · ·		- it
Name of Teacher or Teachers			., .	3 m. O .
Their private addresses	*			union to
Total No. of indi				

CLASSES IN (state subject).	Fees.	No. of Students.	Days on which they meet.	Hours of Meeting.	Period of the Year during which the Classes continue
			-		
			-		
				•	

NAMES OF SECRETARY AND MEMBERS OF THE COMMITTEE.

(The undertaking on Science Form, No. 88, is for the year at least, and further till another Committee satisfactory to the Science and Art Department has been appointed. This Form, No. 88, must therefore be filled in and sent to the Department annually when the class recommences, except in those cases in which the whole of the Committee, wishing to continue, formally authorize the Chairman and Setretary to report to that effect. It will then only be necessary for new members to sign the form undertaking to perform the various duties.)

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SCIENCE FORM, No. 119.

SCIENCE SCHOOL FOR EXAMINATION IN MAY.

To be sent to the Secretary of the Science and Art Department before the end of March. APPLICATION FROM

	Group L.	Group II. Group III. Group IV. Group V. Group VI. Group VII. Group VIII.	п	Group	H.	Group	Ę.	Grou		Group	M.	Group	H.	Group	VIII			-	
	Geometrical Drawing,	Mechan- ical Physics.	ទំ ខំ	Experi- mental Physics.	ig S	Chem	Chemistry.	Geol an Miner	Geology and Mineralogy.	- 644	Animal hystology and Zoology.	Physiology, Economic, & Systems- tic Botsny.	pology mic, mic,	Min. s.p. Metall	Mining and letallurgy.	 Nex	Navigation.	ਵੀ	
-	Subject.	Subject.	- i	Subject.	ję.	Subject.	 80 f.	Subject.	Set.	Subject.	Sct.	Subject.	ot.	Subject	1 6 ct	20	Subject.		
	i. n. nr.	I.	п.	п п	п	I	т п.	т п	Ή	т п	11	T II	Ħ	I. II.	Ħ	ä	11	I. II. III. IV. V.	
Number of students under in-} struction during the year -}						-			= ===				±::=			 			
Number intending to present } themselves for examination }		-														 		<u></u> -	
Number intending to present) themselves for examination not belonging to the class -)	· ·																		

Total number of students * under instruction during the year

Name and address of the person to whom the examination papers are to be sent. Total number of students * intending to present themselves for examination_

Specify here the arrangements which have been made in accordance with § XIII. of the Science Directory to conduct the examination of N.B.—The address must be that to which the Examination papers are to be sent.

* The total number of indicidual students only should be here given, so that if one student attends two or more classes he must only be counted as oss. any other classes in the town (if there be any) at the same centre.

FORM No. 363.

The following form, which may be had on application to the Secretary, Science and Art Department, is filled up in italics as an example of the manner in which it should be done.

An Account of Travelling and Personal Expenses disbursed and CHARGED BY

Thomas Jones.

From the 2nd January 1860, to the 4th January 1860.

I hereby certify that the travelling expenses detailed below have been actually disbursed by me in travelling in the execution of my public duties, that the personal expenses are charged according to the regulations, and that the is due to me for the services stated. total sum of £

In this column must be stated the service on account of

which the journeys were performed, and the details of the expenses incurred.

Date

upon which the

services were

Performed.

Thomas Jones.

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TOTAL

AMOUNT.

[Name and title of officer to be specified.]

Teacher of Chemistry in _____School of Manchester.

1860. Ind January. Srd January.	South Ke Railway f (and Clas Omnibus fo	examination in Chemmsington on 3rd Janua are from Manchester 18) are to and from Euston Insington	ry 1860. r to Lond n Square a	on nd	1 4				
4th January.	Railway fo	msington	lanchester	•	1 4	0			
,	s days' pers	onal allowance at 10s.		•	-	-	2	9	0
					•	-	8	9	<u> </u>
NOTE.—Should at night, he is on Examined an	dy to be allow	ul candidate live in L ed ss. per diem besides	ondon or n his travell	ing	exp	ugh to mess.	get	ho	m∉
		8	Secretary.				•		
Received th	is	day of		_18	3	, the	50	m	of
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•		_	nd			pence,	in		, ,

SCIENCE FORM No. 51. South Kensington, July 1864.

SCIENCE AND ART DEPARTMENT OF THE COMMITTEE OF COUNCIL ON EDUCATION, SOUTH KENSINGTON.

Application fro			Scien	nce Teacl	ler in		
School or Instituti	on at_			f	or payment.		_
On behalf of the	e Comr	nittee of Man	ageme	nt of thi	s School, We do	here	eb y
(1). That Mr			has	duly perf	ormed the variou	s du	ies
devolving	upon hi	m as a Scienc	e Tea	cher in	the School, duri	ng	the
(2). That he ha	s given r since	the following	Stud	lents at 1	least 40 lessons n payment was	duri elain	ing ned
(3). That the u	ınder-m	entioned stude	ents ar	e <i>artizan</i>	s or operatives *	in	the
receipt of weekly:	wages, i	supporting then	selves	by their	own manual lab	our ;	or
their children not e	earning	their own liveli	hood.				
					Secreta	ry.	
					} Two		
					Com	rs of	
I hereby certify	that th	e following pa	rticula	rs are co			
	V-100 011	o rono wing pu					
					Tea	ener.	•
N.B.—These names and is claimed and the last t of these and th	s OF P. should l on in n hree colu he whole	ASSED ARTISAN be arranged alp ore than one su ums filled up wi amount claimed	habeticable the latest that the latest that the latest lat	PERATIFE cally. If t the name, several su candidate	he same student or &c. should be ditt ccesses, so that the may appear in one	omes o dit o wh place	up to, ole e.
Surname, Christian name in full.	Age last Birth- day.	Trade, or father's trade. (State which is given).	tł	ition at ne late nination.	Highest Position in same Subject at any previous Examination.	Ame	
1			Group.	Sub. Class.	1	£	8.
1. 2.				;		<u> </u>	
3							
4							
5							
6	·						
7	ļ						
8						-	
9	·					-	
&c. &c.							

^{*} Should the Teacher have instructed any Students who may fairly be considered to belong to the industrial classes, but whose wages are paid at longer intervals than a week, or who do not support themselves by their own manual labour, the claims on their account must be made by the Committee of the school on the form on page 5, when they will be considered on their merits.

22 On behalf of the Committee of the School, We, the undersigned, beg leave to recommend that the Teacher, Mr. _ be allowed to claim the allowances on the following students, whom we consider may fairly be taken as belonging to the industrial classes, as coming within one of the following categories, or being the children of such. a. Though paid at longer intervals than a week, still supporting himself by his own manual labour and not by profit on the labour of others, that is not employing apprentices, journeymen, &c. b. Though not supporting himself by manual labour, yet being of the same means and social level as those who do so (such as shopkeepers who have only petty stocks and employ no one but members of their own family), policemen, coast-guards, &c. c. Though not supporting himself by manual labour, yet such as it would be unreasonable to expect to pay the fee of middle class students, as some descriptions of clerks, shopmen, &c. We certify:-(1). That he has given them forty (40) lessons at least during the year, or since the last examination at which payment was claimed on their account. (2). That they, or—in case they are not earning their own livelihood—their fathers are not assessed to the income tax. (3). That the following particulars on which the Teacher grounds his application are correct. Secretary. Two members of Committee. I hereby certify that the following particulars are correct. Teacher. NAMES OF PASSED STUDENTS CLAIMING AS INDUSTRIAL CLASSES. N.B.—These names should be arranged alphabetically. If the same student comes up and is claimed on in more than one subject, the name, &c. should be ditto ditto, and the last three colums filled up with the several successes, so that the whole of these and the whole amount claimed for a candidate may appear in one place. Highest Position Age last Trade, or Position at Surname. Christian father's trade. in same subject Amount the late name in full. Birth-(State which at any previous Examination. claimed. Examination. day. is given). 8. Group. | Sub. | Class 1)._ &c. &c. The Secretary, Science and Art Department.

(The following particulars will be filled up at South Kensington).

day of

_day of__

Examined and found correct to the extent of

Approved '

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CONDITIONS UNDER WHICH APPARATUS, INSTRUMENTS, BOOKS, &c. MAY BE OBTAINED BY SCIENCE SCHOOLS OR CLASSES (TAUGHT BY A TEACHER CERTIFICATED IN SCIENCE),* IN PUBLIC SCHOOLS, MECHANICS' INSTITUTIONS, &c.

1. The Lords of the Committee of Council on Education, having had under their consideration several applications from the managers and masters of Mechanics' and other Institutions, for grants to be made to them of Apparatus and Illustrations, recommended by the Science and Art Department for teaching science, think it necessary to adopt some general principle which shall regulate the decisions of the Committee in reference to such applications.

Their Lordships have already fully recognized the great importance of practical science to all classes of the community, in all relations of life. They are, therefore, desirous that the Science and Art Department should assist, as far as possible, in promoting the distribution of diagrams and apparatus as the means of accomplishing this object; but as the indiscriminate gift of these aids for instruction to all applicants might lead to abuse, it is necessary to require some guarantee that they will be duly appreciated, which the mere request to have them does not imply.

The principle which governs the whole proceedings of the Department in all its branches is to afford partial aid, and to encourage, but not supersede public exertions in promoting education in science. They have, therefore, resolved that the Department shall have the power to assist schools and classes taught by a certificated teacher in Mechanics' and other institutions in purchasing diagrams and apparatus for teaching science at a reduction of 50 per cent. on the net cost.

Lists of the scientific diagrams and apparatus prepared by the Department, according to conditions of the following Minute, may be obtained of the Secretary of the Science and Art Department, South Kensington, London, W. It should be distinctly understood that the aid of the Department in purchasing these articles at a reduced price, if above 101. in value, can be granted only to public schools and institutions when taught by a certificated teacher.

Minute of the 23rd March 1860.

"The Lords of the Committee of Council on Education desire to afford the greatest facilities to teachers of science and navigation schools in obtaining the best instruments, apparatus, &c., for giving instruction in science and navigation, towards the purchase of which the Science and Art Department is authorized to pay 50 per cent. of cost; and they consider that the fullest opportunities should be given to manufacturers in all parts of the Kingdom for supplying such apparatus, &c. At the same time it is necessary that the Science and Art Department should have some guarantee that the apparatus and instruments are of good quality,

4.00

Apparatus not exceeding 10% in value may be obtained by poor Schools and Mechanics' Institutes, not taught by a certificated teacher, under the same conditional that is, the Department will aid them to the extent of 5%.

and moderate in price. My Lords have therefore laid down the following rules and conditions:—

- "1. Samples of all articles on the manufacturer's list are to be sent to the Educational Collection, South Kensington Museum, for exhibition, where they will be arranged separately, according to the science for which they are intended, so as to afford teachers and others facility in inspecting them and making a choice.
- "2. The manufacturer is to supply priced catalogues of such articles printed in demy 8vo., in order that the various catalogues may be bound up together and supplied when asked for.
- "3. The manufacturer is to guarantee that the articles exhibited are fair samples of those specified in the priced catalogue, and he must engage to take back any article supplied to schools which may be inferior to the standard."

Manufacturers willing to comply with these conditions are to make a statement to that effect, and to send lists of apparatus, instruments, books, &c. in the following sciences:—1. Practical plane and descriptive geometry, mechanical and machine drawing, and building construction; 2. Physics (mechanical and experimental); 3. Chemistry; 4. Geology and mineralogy; 5. Natural history (zoology and botany, vegetable and animal physiology); 6. Navigation and nautical astronomy, and physical geography. If these lists and prices are such as can be approved of, the manufacturer will be informed, and as soon as possible on his fulfilling the conditions, his list will be inserted in the catalogue. The catalogue will undergo a revision at least once a year, when manufacturers may send any improved forms of apparatus, &c.

The selection of the manufacturer will lie wholly with the Committee of the school. On their demand being sanctioned, the manufacturer will receive instructions to supply the articles upon his receiving the 50 per cent. due from the school.

On obtaining a receipt from the Committee of the school (which is included in the form of the requisition) that the articles have been received, the remaining 50 per cent. will be paid quarterly to the manufacturer by the Department.

2. Payments, including charge for packing, must be made in advance to the agents on receipt of the invoice. The goods to be sent at the risk of the purchaser.

All communications to be addressed to the Science and Art Department, South Kensington, London, W.

By Order of the Committee of Council on Education.

N.B.—Apparatus grants will in future be rigorously confined to articles of a permanent and non-destructible nature; hence no aid will be afforded in the purchase of breakable articles, such as glass retorts, test tubes, &c., or, indeed, generally in the purchase of articles to be used by the student as distinguished from those of a permanent and illustrative character which are required by the teacher in giving instruction in science.

SCIENCE FORM, No. 49.

FORM of REQUISITION which may be had on application to the Secretary, Science and Art Department.

The following Requisition for Aid in purchasing apparatus, &c., after being filled up as required, is to be transmitted to "The Secretary of the Science and Art Department, South Kensington, London. W."

N.B.—It is to be understood that the Department has a lien on the apparatus, &c., furnished to public institutions to the amount of the public aid given in supplying them: they cannot therefore be sold.

them; they cannot therefore be so	ld	
1. REQUISITION for A	.ID in purchasing apparatus, &c. School or Institution (*)	No. 1 appli-
In the City or Town of (a)	2000000 0000000000000000000000000000000	filled in by
In the County of		Requision-
Male Fema		ist, with full par-
Having (*) Erase the words that io not apply.	(*) Pupils (Artizans or Operatives) of the Science Class. (*) Scholars or Members of Poor School or Me-	ticulars.
	chanics Institute. Total.	
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kept and used in the above-ment been demanded. The address to which the parcel To be forwarded to	pposite page, and I undertake that the same shall be ioued (*) school or institution for which they have is to be sent is as follows:—	
,	Signature of Requisitionist.	
Dated this	day of186 .	
and authority given for the	Agent supply of Articles to the extent	No. 2 to be filled in by the Department.
of which &will be paid	et Sum by the Department, and £, together with	
the cost of packing, by the so applied.	chool or institution, previous to the goods being	:
appneu.	Assistant Secretary.	
3. Invoice of articles sent to Required 186	uisitionist as under, this day	No. 3 to be
Articles (Reta	ail Price) - £	filled in by agent on transmis-
Aid by Department -		sion of the invoice.
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5. Examples forwarded as direct	and shows together with Despisition this	
day of	—186 . Agent.	37. 4
	yed, and *Requisition returned to Agent, this 186 Requisitionist.	Requisition-
		ist "

^{*} It is requested this paper may be returned to the Agent in an entire state after the examples have been received.

SCIENCE FORM, No. 91.

Rules for the Conduct of Science Examinations.

1. The following rules must be hung up in the examination room for the information of the candidates one week before the examination. They should all be carefully read by the members of the Committee, and those marked with an asterisk must also be read aloud before the Committee and the candidates on each night immediately before the examination begins.

2. A room or rooms of such a size that, when seated, the candidates shall be at least five feet apart, from centre to centre, must be provided

for the examination.

* 3. All Diagrams, &c. must be removed from the walls of the examination room.

Ink and blotting paper must be provided.

5. If one room is used three of the Committee must be present during the whole of the examination, if more than one room then two of the Committee per room,* who must carefully watch the whole examination and see that candidates use no unfair means either by assisting one another or using books or notes. The members of the Committee can, if they wish it, relieve one another, so long as the correct number are always present.

6. The examination papers will be forwarded, under cover, to the Secretary of the Committee so as to be received by him on the morning

of the day fixed for the examination.

*7. The candidates must be seated at their places at 6.50 p.m. After this time no candidate shall be admitted except under very exceptional circumstances, and that only by express permission of the Committee. No candidate may on any account be admitted after 7.30 p.m.

* 8. The examination papers must be opened in the examination room in the presence of the Committee, at 6.55 p.m. No examination paper

may be taken from the room till after 8 p.m.

*9. When the candidates are seated and the papers given out, the Committee will see that the candidates commence by filling in their names, &c., where directed. All the worked papers must be collected at 10 p.m., initialed, put under cover, and sealed in the presence of the members of the Committee; and forwarded by the first post to the Secretary of the Science and Art Department.

* 10. Candidates must on no account bring anything with them into the examination room, texcept pens and pencils. No scribbling paper, slates, or anything of that nature must be allowed. T Arrangements must be made by which all books, note-books, &c., can be given up and left at the

door.

* 11. Candidates must not on any pretence whatever speak to one another after the papers have been given out. If a candidate should require to ask a question, he will hold up his hand, when a member of the Committee will attend to him, but no question on the meaning of any portion of the examination paper must be asked or answered.

12. It may be of service to the Committee that the teacher of the class should attend before the examination to assist in getting the candidates into their places, &c.; but from the peculiar character of the

^{*} When there are not more than three candidates it will not be necessary for more than two members of the Committee to be present at the examination.

† Except in the drawing examination, when drawing instruments are allowed.

‡ It is absolutely necessary that nothing that can be passed from one candidate to another should be allowed. Rough work and calculations must be done on the supplied form. If necessary the last page or pages may be taken for this purpose, but they must not be torn off.

examination it is so very necessary that not the slightest opportunity for misconstruction should exist that it is evident that he should not be in the room after the examination papers are opened. Information of his having remained in the room after this will at once lead to the examination being declared null.*

*13. The examination papers being given out no candidate must be allowed to return after having once left the room. † On a candidate

leaving the room his papers must be taken up.

* 14. At 10 p.m., precisely, all the candidates must cease working, and members of the Committee will collect their worked papers from them at their places. It will therefore be advisable to warn them ten minutes before the time. The papers will be initialed, by the Committee as directed, as they are received from each candidate, as a guarantee that each has been worked by him whose name, &c., it bears. Should a candidate have completed his work before 10 p.m. he may, by permission of the Committee, go away at once, after his worked paper has been taken by a member of the Committee.

* 15. Should a candidate break any of the foregoing rules, ask from or give information to another, or use unfair means of any description, he must be at once expelled the examination room, and his paper cancelled,

and the Committee will state on it the cause of his expulsion.

16. On these examinations depend large grants of public money. their being fairly, honestly, and impartially carried out depends the continuance of the system. The Committees are intrusted with this duty. They will see, then, how necessary it is to be extremely careful in conducting them, and to insist on the foregoing rules being complied with to the letter. They are therefore required to sign and forward this form with each set of worked papers.

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on the evening of the papers were worked in our price been strictly complied with.	held in the where tesence, and that the fore	he accompanying
	day of	186
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^{*} Should the teacher of the class wish to compete at this examination for the Royal Exhibitions of the Royal School of Mines, he must apply especially to the Committee for permission, so that they may arrange to have a table for him close to their own seats, and not with the other candidates.

† It will, therefore, be desirable to make some arrangement for the candidates to retire within the room.

SYLLABUS OF THE SUBJECTS IN WHICH CERTIFI-CATES AS TEACHERS OF SCIENCE ARE GIVEN BY THE DEPARTMENT OF SCIENCE AND ART.

THE following Syllabus has been prepared in order to afford candidates for certificates as teachers of Science, some guide to their reading; but it must be understood that the questions in the examination need not

necessarily be on the specific points enumerated.

The examination is by paper, but oral examination may be resorted to, and satisfactory evidence may be required of the teacher's power of giving information to a class. The groups are divided as shown, the examination in each subject being distinct, so that candidates may, if they desire it, take a certificate only in one subject of a group. Mention is made of text-books solely to afford a candidate some assistance in selection and a general idea of the scope of the examination, and not at all to confine his reading to those works or to assert that they are the best on the subjects they treat of.

Any certificate obtained at the examination may be raised, by reexamination, in the next or any following November to a higher grade.

A Course of Lectures as detailed below, on "Preparation for obtaining "Science Certificates and the Method of teaching a Science Class," has been delivered by direction of the Lords of the Committee of Council on Education. The lectures may be purchased, price 2d. each, at the book stall, South Kensington Museum. or on application by letter, enclosing postage stamps, to the Secretary, Department of Science and Art, South Kensington, London, W.

Group I. - Geometrical Drawing, &c. Prof. T. Bradley.

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" II. - Mechanical Physics " III. - Experimental Physics " IV. - Chemistry - - - Prof. Hofmann, F.R.S.

V. - Geology - - Prof. Ramsay, F.R.S. Mineralogy, &c. - Prof.W. W. Smyth, M.A., F.R.S.

Mineralogy, &c. - Prof.W. W. Smyth, M.A.,
VI. - Zoology - - Prof. Huxley, F.R.S.

", VII. Botany - - Edwin Lankester, M.D., F.R.S.
Navigation and Nautical J. Riddle, F.R.A.S.

Astronomy.
Physical Geography - Dr. G. Kinkel, F.R.G.S.

A Second Course has been delivered, of which the following have been published:—

Lecture I. - Vegetable Physio- Edwin Lankester, M.D., 3rd February. logy and Econo- F.R.S. mic Botany.

Lecture II. Mechanical Physics Rev. B. M. Cowie, B.D. 10th February. Lecture IV. Mining - W. W. Smyth, M.A., 24th February. F.R.S.

SYLLABUS.

GROUP I.

PRACTICAL PLANE, AND DESCRIPTIVE GEOMETRY, MECHANICAL AND MACHINE DRAWING, AND BUILDING CONSTRUCTION.

This group consists of three subjects, viz.,—(first subject) Practical Plane, and Descriptive Geometry. (Second subject) Mechanical and Machine Drawing. (Third subject) Building Construction. And it is open to the candidate, to pass in either of the subjects alone, or in all, but a teacher will not receive any payments for Subjects II. or III. until he is certificated in I.

Subject I.—Practical Plane, and Descriptive Geometry.

Practical Geometry, plane and solid; required by architects, engineers, mechanists, shipbuilders, and others employed in arts of construction.

The candidate is expected to have acquired readiness in the use of the usual drawing instruments and materials, to be skilful in drawing lines and circles in Indian ink, plain or dotted, of different degrees of fineness; drawing parallel equi-distant lines, at least six inches long, and from five to twenty or thirty in an inch; drawing from ten to thirty lines, passing through one point and forming equal angles; dividing by trial lines and arcs into any number of equal parts. He should also be able to mend his drawing pens and other instruments, and to verify his rulers, &c.

Constructions in Plane Geometry.

 To draw lines through given points, in every position, either parallel, perpendicular to, or to form any proposed oblique angle, with given lines.

The use and construction of the *protractor*, and of the "scale of chords" for these purposes, should be understood, and the deduction of certain angles from the direct division of the circle.

To draw circles or arcs, through given points, to touch given lines or circles, and, conversely, lines to touch circles.

Required in drawing framework for machinery, architectural designs, ornamentation, &c.

The principles of drawing symmetrical forms by means of co-ordinate to the axis of symmetry.

This is the basis of all drawing, of all objects of construction, which are universally symmetrical, not only in architecture, civil and naval, but in machinery and engineering works of all kinds.

 Constructions of figures similar to given rectilinear or mixtilinear figures.

Here the construction and use of "scales" plain and comparative, should be thoroughly understood and explained, and the principles of the diagonal and the vernier subdivision. Also the mode of reducing or enlarging drawings by means of similar rectangles, termed quarring a drawing. The use of the sector and of proportional compasses, and of the pentagraph and eldograph, in facilitating copying should be known.

- To construct rectilinear figures similar to given ones, but with a proposed area.
- 6. To determine by construction numerical quantities such as \sqrt{m} ; $\sqrt{\frac{a^2+b^2}{m}}$, &c.
- 7. To construct a triangle, any three parts being given.

Used in levelling, surveying, and the determination of heights and distances. Great accuracy, neatness, and distinctness of construction, will be insisted on: Geometrical drawing is valueless unless it possesses these requisites. A few illustrations of constructions on the ground, by means of a "chain," pins and cords, necessary in surveying, and "setting out" buildings and earthworks, may be added to the course, as well; as the solution of a few elementary problems by means of the compasses alone.

8. The delineation of a few of the curve lines required in the arts, such as the ellipse, cycloidal curves, the involute and sinusoid, with the graphical method of determining their tangents and normals.

Required in designing elliptic arches, oblique bridges, teeth of wheels, cam-work, screws, &c.

- Practice in tinting and shading with Indian ink, so as to express curved surfaces and shadows.
- For the preceding part of the course, a fair knowledge of the first six books of Euclid is strongly enjoined, some acquaintance also with trigonometry will be of service, as without such previous knowledge, the learner is simply copying what is set before him, and cannot attain the highest skill in drawing.

Constructions in Solid Geometry.

(Descriptive Geometry.)

Preceded by explanations of the term projection, and of the necessity for it, in order to express graphically, on a surface, solids of any kind; the distinction between orthographic and perspective projections; their uses, and general principles which are the foundation of their practical application.

Orthographic Projection.

- Why the projections, of any solid consisting of a combination of geometric forms, on two or three co-ordinate planes are necessary to show the form and dimensions of that solid.
- Meaning of the terms plan, elevation, profile, section. The principle of the representation of surfaces by the projections of their generators, or of equi-distant horizontal sections termed contours. The direction and inclination of an indefinitely extended plane given by its contours, or by its traces on any two co-ordinate planes.
- These principles should be quite familiar to the candidate, and will be tested by making him draw plans, elevations, and sections of simple solids, as prisms, pyramids, cones, spheres, cylinders, and of symmetrical solids formed by their combinations.
- A few of the problems relating to points, lines, planes, and curved surfaces, will be required, as—
- 1. To draw lines and planes parallel or perpendicular to each other, to contain given points or lines, and the limits of the possibility of solution of any problem should always be understood.

2. The preceding constructions combined and applied to determine by their projections the simple solids before mentioned, when they are not symmetrically situated with respect to the supposed planes of projection.

3. Applications to the intersections of surfaces, and of the development

of such as admit of it.

This may be considered the most important part of descriptive geometry to the artizan, as it is required in all arts of construction. The mason, carpenter, and shipwright, workers in tin-plate, boiler makers, &c., would all be benefited by a knowledge of it.

This application has been termed Stereotomy, and better and more significantly in French, "Coupe de pierres."

Much practical knowledge of the subject, arising from their pursuits, is possessed by workmen, while the want of a scientific knowledge of it compels architects, engineers, and their drawing clerks to leave to the workmen the execution of their conceptions which they cannot themselves design.

4. The solution by construction of the spherical triangle from any three

given parts, is mentioned.

As important to masters, mates, and others engaged in any kind of astronomical calculations.

Isometric Projection.

Is usefully employed in the representation of works chiefly of a rectangular form, such as timber framing, canal-locks, and many parts of machinery; its use is much increasing: it is readily understood, and can be practised by anyone who has gone through the first two articles of this section.

Perspective Projection.

May be taken up, but will not be insisted on as it is rarely used except by architects to represent buildings (not yet executed), as they would appear to the eye at any spot from which they could be viewed, and the power of applying it for this purpose is possessed by many who know little of the really easier subject of descriptive geometry; but as its application by the architect must be subordinated to artistic taste, this consideration excludes it, in some measure, from a purely geometrical course.

No one, however, can be considered a scientific draughtsman unless he can apply perspective projection to the projection of shadows, the projections of the sphere, the constructions of maps and dials, and

some other uses.

For the second division of this course, in addition to what was before indicated, a competent knowledge of the theorems relating to the line and plane (Euclid, Book XI.), and an acquaintance with the leading properties of the conic sections, the geometry of the sphere, and some spherical trigonometry is important, it cannot be too urgently recommended to all persons wishing to master this course, to study such works as "Geometry, Plane, Solid, and Spherical" of the Library of Useful Knowledge, and Mr. Bell's, in Chambers' Educational Course.

Geometry, Plain, Solid, and Spherical (Library of Useful Knowledge) is especially recommended as a work to be studied on Theoretical Geometry. Text-Books for Practical Plane Geometry.—Bradley's Geometrical Drawing; Burchett's Practical Geometry; Practical Geometry, Linear Perspective and Projection (Library of Useful Knowledge).

For Descriptive Geometry.—Bradley's Geometrical Drawing; Hall's Elements of Descriptive Geometry for Students in Engineering.—Heather's Descriptive Geometry. Also the following French Works, which are mentioned in consequence of the great deficiency of English Works on Geometrical Drawing.—Elémens de Géométrie Descriptive, par S. F. Lacroix; Traité de Géométrie Descriptive, par Levebure de Fourcy; Nouveau Cours raisonné de Dessin Industriel, par Armengaud, aîné, et Armengaud, jeune, et Amouroux; Bardin's Works on Descriptive Geometry.

Subject II.—Mechanical and Machine Drawing.

- The candidates in Subjects II. and III. will, some time before the examination, have specifications of subjects given to them, of which they will be required to prepare drawings before the examination. These drawings must be bond fide their own. The candidates may be examined on them, and if the results be satisfactory, they will count towards their certificates, but they will only be taken into consideration when it is clearly seen from the regular examination that the candidate is qualified for a certificate.
- The application of the foregoing Subject I. to the drawing of machinery, in which great accuracy and neatness of drawing will be insisted on.
- The candidate will be required to take measurements with calipers, &c., and to make drawings, elevations, and sections of a simple machine, or of parts of one, set before him. Also to draw a portion of a machine from written dimensions and description. He will be required to have sufficient knowledge of the principles of machinery, gearing, &c., to be able to make working drawings of a machine or portions of a machine from a rough sketch, applying the power to the greatest advantage, and obtaining such power or changes of motion as are required. In fine, such knowledge and readiness as would be required of a good draughtsman in an engineer's office.

Subject III.—Building Construction, or Naval Architecture.

(See previous Subject.)

- The candidate will be required to possess sufficient knowledge of construction—(1) to apply the various materials used in building to their greatest advantage; (2) to be able to make detail and working drawings showing a knowledge of the methods of construction and the framing of ordinary roofs, bridges, &c., whether of wood, iron, or masonry; (3) to frame estimates and take out quantities.
- Neatness, accuracy, and facility in drawing will be insisted on, and the general requirements in this Subject will be such as would be possessed by a good draughtsman in an architect or builder's office, with a slight scientific knowledge for the proper application of the materials he is required to work with.
- N.B.—Naval Architecture may be taken instead of Building Construction; the same description of attainments will be required.

GROUP II.

MECHANICAL PHYSICS.

This group is taken under two subjects.

Subject I .- Mechanics as a Science, or Theoretical Mechanics.

Statics. Composition and resolution of forces. Forces acting on a point—on a rigid body. Parallel forces. Centre of gravity. Theory of moments or couples. Principle of virtual velocities. The mechanical powers. Friction. Equilibrium of roofs and arches.

Dynamics. Laws of motion. Uniformly accelerated motion. Motion by gravity Variable forces. Projectiles. Centrifugal force. Motion on inclined planes—on curves. Pendulums. Motion of rigid bodies, free or constrained. Moment of Inertia. Centre of oscillation-of percussion. Motion of flexible bodies, such as a musical string.

Hydrostatics, Hydrodynamics, and Pneumatics. Mechanical properties of liquids. Law of pressure. Centre of pressure. Laws of floating bodies. Capillary attraction. Laws of fluid motion, through open

channels, closed pipes, or orifices.

Mechanical properties of elastic fluids. Theory of barometers. Connexion between pressure, temperature, and volume. Specific heat. Weight of atmosphere. Use of barometer in calculating heights.

In this subject the candidate will have to show a mathematical knowledge of the laws of Mechanics, and must be able to prove from

first principles the principal theorems.

The books recommended for study are—Whewell's Elements of Mechanics, or Snowball's; Moseley's Engineering Architecture; Natural Philosophy, by Dr. Golding Bird and Mr. Brooke; Goodwin's Elementary Course.

Subject II.—Mechanics as an Art, or Applied Mechanics.

General principles of mechanism. Elementary combinations. When the connexion is by rolling contact, sliding contact, wrapping connectors or linkwork, with constant or varying velocity ratio, and constant or

varying directional relation.

Machines of ordinary occurrence must be thoroughly understood and particular parts to be described and drawn: such as cranes; lathes; drills: planing, punching, boring, shaping, and slotting machines. Spinning and weaving machinery. Mode of calculating power of machinery. Dynamometers, indicators, &c.

Materials. The general properties of materials. Elasticity. Weight. Specific weight. Mechanical work. Work done by pressure, by impact, by expansion of elastic gases and steam, by animal muscular

effort.

Resistance to expansion, to compression, to rupture. Friction of solids. Its importance in construction. Resistance of fluids to bodies moving within them. Adaptation of form and material for maximum resistance. Beams of greatest strength. Construction of roofs, arches, stone and timber bridges, suspension bridges, and

tubular girders.

Hydrostatics, Hydrodynamics, and Pneumatics. Pressure on floodgates; locks; water-wheels; turbines; water-pressure engines; breakwaters. Hydrometers. The syphon. Hydraulic ram. Pumps. Diving bell. Condenser. Windmills. Steam-engines, stationary, Diving bell. Condenser. marine, locomotive. The steam hammer. Water supply to towns. Theory of tides, in the open sea, and in rivers.

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In this subject the candidate will be expected to show how the principles are applied in actual practice: he will be expected to show by clear well-drawn sketches, his acquaintance with parts of machines.

The candidate will have tools and models put before him, with some of which he must show he is familiar, and that he can explain their use

and construction.

Books recommended,-Willis's Mechanism; Baker's Elements of Mechanism: the books in Weale's Series which treat on the subjects specified. Twisden's Practical Mechanics; Goodeve's Elements of Mechanism.

GROUP III.

EXPERIMENTAL PHYSICS.

This group is taken under two subjects.

Subject I.—Acoustics, Light, and Heat.

Acoustics.

The candidate ought to know the manner in which sound originates, and is propagated; its velocity in different media, and how its velocity

through air is affected by density and temperature.

He ought to know the origin of musical sounds; of pitch; of harmony and discord; to commit to memory the rates of vibration of the several notes of the gamut; to be able to make sonorous vibrations visible by means of glass plates and membranes; to calculate the length of sonorous waves, and to determine practically the number of vibrations due to any particular note. He ought therefore to understand the construction and use of the Syren.

He ought to be able to describe and illustrate the condition of a vibrating string, or column of air at its nodal points and ventral segments and to explain echos and resonance.

Light.

The candidate ought to know how its velocity was first determined from

observations upon Jupiter's satellites.

He ought to be able to devise a simple means of exhibiting both the reflection and refraction of light; to be able to state the laws of both; to explain what is meant by total reflection; and to apply it to the explanation of the Mirage of the Desert, the Phantom Ship, and other similar phenomena.

He ought to be able to explain why the image in a plane mirror must appear as far behind the mirror as the object is in front of it; why a stick appears bent when dipped obliquely into water; and why the hottom of a river or lake, or of a basin which holds water, appears to

be nearer to the surface than it really is.

He ought to be able to determine the positions of the foci of spherical mirrors, both concave and convex; to describe the characters of their images, whether erect or inverted; magnified or reduced; and to do the same for convergent and divergent lenses.

He ought to know the construction of the human eye; the conditions of distinct vision, the use of spectacles; and to be able to describe a simple form of the reflecting and refracting telescope and of the

microscope.

He ought to know the constitution of light; to be able to describe the spectrum produced by refraction with a prism; to explain the origin of colours, and to give a clear explanation of the rainbow.

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Heat.

The candidate ought to be able to describe the construction and graduation of an ordinary mercurial thermometer; to understand the scales of Fahrenheit, Celsius, and Reaumur.

He ought to have clear ideas of conduction and radiation; to be able to devise some simple means whereby the conductive and radiative powers of different bodies may be determined; to explain fully the formation of dew, and to state the conditions favourable to its production.

He ought to know the effect of heat upon the volumes of bodies; to know what is meant by the coefficient of expansion, and how it may be determined; to give illustrations of the enormous power of heat in producing expansion; to state exceptional cases; to know the manner in which heat is propagated through liquids and gases, as distinguished from ordinary conduction; and to be able to combine two metals possessing different coefficients of expansion, so as to form a compensating pendulum.

He ought to know the meaning of latent heat and of specific heat, and to illustrate both by reference to ice, water, and steam; he ought to be able to show the influence of the high specific heat of water upon

an island climate.

He ought to know the strict physical meaning of ebullition; and the influence of pressure upon the boiling points of liquids; he ought to have a general knowledge of the origin of winds and clouds, and to be able to explain the fact that the rain-fall upon the south-west side of a mountain chain in England and Ireland is much more copious than on the north-east side.

Subject II.—Magnetism and Electricity.

Magnetism.

The candidate ought to know the action of one loadstone upon another which is freely suspended, or set afloat upon a liquid; he must have a perfectly clear notion of magnetic polarity, and of the action of magnetic poles upon each other.

He must know the difference between the action of magnetised and unmagnetised steel upon a magnetic needle; also the difference between soft iron and hard steel, with regard to their acceptance and

retention of the magnetic condition; (coercive force).

He must be able clearly to state the condition of a mass of soft iron when under the influence of a magnet, and in virtue of which condi-

tion the iron is attracted; (magnetic induction).

He must be able to describe the action of the earth upon a magnetic needle; must know the meaning of declination, inclination or dip, and of secular and diurnal variation; the action of the earth upon a bar of soft iron according as it is held in the direction of the dip or at right angles to this direction; finally, the effect of percussion in rendering the condition assumed by the bar of soft iron a permanent one. He ought to be able to compare accurately the strength of one magnet

de ought to be able to compare accurately the strength of one magnet with that of another, and to state how the relative intensity of the earth's magnetism at two points of its surface may be ascertained.

Frictional Electricity.

The candidate ought to know various simple ways of exciting electricity to be clearly informed as to the duplex character of the force; to know the condition of the rubber as well as that of the body rubbed; and to be conversant with various forms of electroscopes and electrometers.

- He ought to know the foundation of the terms vitreous and resinous, positive and negative; to be able to illustrate the action of two electrified bodies upon each other; and to tell at once whether a body is positively or negatively charged.
- He ought to have a clear knowledge of electric conduction, insulation, and induction; and be able to explain the state of a neutral conductor when acted upon by an electrified body; he ought to be able to prove, experimentally, that though we cannot by breaking a magnet obtain two halves each with a single pole, we can by breaking an electrified body obtain two halves each charged with a single electricity.
- He ought to be able to explain the influence of points and flames when attached to an electrified conductor; and to describe the action of lightning conductors.
- He ought to be able to describe the electric machine, and the electrophorus; and to explain the action of the condenser and of the Leyden jar.
- He ought to be able to state the principal effects of the electric discharge; to state the atmospheric conditions necessary to the production of a thunderstorm; and to give a clear account of the so-called return stroke.

Voltaic Electricity.

- The candidate ought to be able to state precisely how voltaic electricity may be generated; to describe Volta's pile, and his crown of cups; and also the batteries of Daniell, Grove, and Bunsen.
- He must have a clear conception of what is meant by the direction of an electric current; and be able to illustrate in the fullest manner the action of a current upon a freely suspended magnetic needle. Given the direction of the current, he must be able to state how the needle moves; given the movement of the needle, he must be able to infer from it the direction of the current.
- He must be able to describe fully the action of a current upon soft iron; and to infer from the direction of the current the nature and position of the magnetic poles, which it excites.
- He must be well acquainted with the chemical reactions which take place both in the batteries, mentioned above, and also in other liquids through which the current may be sent.
- He must be able to measure the strength of an electric current, and he is strongly recommended to master thoroughly the law of Ohm, regarding the mutual relations of electromotive force, resistance, and strength of current.
- He ought to be acquainted with the so-called polarisation of metallic plates between which a current passes through a liquid, and to show how this is avoided in Grove's battery.
- He ought to be able to give a clear description of some one form of the electric telegraph.
- He ought to be acquainted with the physiological effects, and with those of light and heat produced by the voltaic current; and to show the dependence of the heat on the strength of the current, and on the resistance which it encounters.

It would also be well to master as much of the phenomena of induced currents as would enable the candidate to explain the action of the

galvanizing apparatus used by medical men.

Norr.—This candidate will perceive that this list is long because the objects to which he is to devote his attention are separately specified. Definition is thus given to his studies and their precise scope marked out for him. He is recommended to repeat with his own hands, as far as it is in his power to do so, the experiments which he finds described in good handbooks of Natural Philosophy; this will give a certainty to his knowledge and an interest to his pursuits which mere reading can never confer. The first requisite demanded of him on his examination will be that, however small his knowledge, it shall be well digested and sound.

Text-Books:—Lardner's Handbook of Natural Philosophy; Natural Philosophy, by Dr. Golding Bird and Mr. Brooke.

GROUP IV.

CHEMISTRY, INORGANIC AND ORGANIC.

This group is taken under two subjects.

Subject I.—Inorganic Chemistry.

The general principles of chemical philosophy. Laws of combination. Combining weights and chemical equivalents. Combining volumes. Chemical symbols and their use in the explanation of chemical changes. The atomic theory.

The non-metallic elements: Oxygen. Combustion.

Hydrogen. Water. Chemical composition and properties. Adaptation for domestic purposes. Hardness, permanent and temporary. Nitrous oxide, nitric oxide. Nitric acid. Nitrification.

Nitrogen. Ammonia.

Process of carbonization. Carbonic oxide. Carbonic acid. Carbon. Marsh gas. Olefiant gas. Manufacture of coal gas.

Sulphurous acid, sulphuric acid. Sulphuretted hydrogen.

Bisulphide of carbon.

Chlorine. Hypochlorous acid. Bleaching agents and theory of bleach-Chloric acid and perchloric acid. Chloride of fitrogen. Chlorides of carbon.

Bromine. Bromic acid and hydrobromic acid.

Iodine. Iodic acid, periodic acid, and hydriodic acid.

Fluorine. Hydrofluoric acid.

Hypophosphorous acid, phosphorous acid. The several Phosphorus. modifications of phosphoric acid: ordinary phosphoric, pyrophosphoric, and metaphosphoric acids. Theory of polybasic acids. Phosphoretted hydrogen. Chlorides of phosphorus. Manufacture of matches.

Boron and boracic acid.

Silicium and silicic acid.

The metals: Potassium. Manufacture of nitre. Manufacture of gunpowder. Theory of the action of gunpowder. Sodium. Manufacture of carbonate of soda.

Barium. Strontium. Calcium. Mortars.

Magnesium, Aluminium. Manufacture of glass and porcelain.

Manganese, Iron, Composition and properties of cast iron, wrought iron, and steel.

Cobalt. Nickel. Chromium. Zinc. Cadmium. Copper. Lead. Manufacture of white lead.

Bismuth. Mercury. Tin. Arsenic. Course of analysis in cases of poisoning.

Antimony. Silver. Gold, and platinum. Their principal compounds with the non-metallic elements.

Outline of qualitative analysis. Reactions of the principal mineral acids and bases. Course pursued in the application of these reactions to the analysis of a mixture of several acids and bases.

The following is the list of Apparatus and Re-agents with which Candidates make their analysis at the examination:—

APPARATUS.

Test tubes and stand.

Metal filter stand.

Wash bottle containing distilled water.

Spirit lamp.

Black blowpipe.

Charcoal for blowpipe experiments.

Iron spoon.

Tongs.

Pestle and mortar.

Watch glasses.
Porcelain crucible.
Triangles.
Test tube cleaner.
Platinum wire and foil.
Funnels.
Cut filters.
Sulphuretted hydrogen apparatus.
Platinum crucible.
Herapath's blowpipe.

RE-AGENTS.

Stirring rods.

In the liquid state.

Sulphuric acid.
Hydrochloric acid.
Nitric acid.
Hydrosulphuric acid.
Potassa.
Ammonia.
Chloride of ammonium.
Sulphide of ammonium.
Carbonate of ammonium.
Chloride of barium.
Chloride of barium.
Chloride of calcium.
Lime water.
Sulphate of calcium.

Porcelain dishes.

Sulphate of pota ssium.
Sulphate of magnesium.
Chromate of potassium.
Oxalic acid.
Tartaric acid.
Acetic acid.
Hydrofluosilicic acid.
Oxalate of ammonium.
Acetate of lead.
Sesquichloride of iron.
Ferrocyanide of potassium.
Chloride of platinum.
Nitrate of silver.

In the solid state.

Carbonate of sodium. Nitrate of potassium. Cyanide of potassium. Borax.

Lime. Sulphate of iron. Blue and red litmus paper.

Subject II.—Organic Chemistry.

Ultimate analysis of organic bodies. Calculation of an empirical formula. Methods of controlling an empirical formula. Determination of the equivalents of organic acids and bases, examination of products of decomposition, determination of the vapour-density of volatile bodies. Law of substitution.

The chemical history of the Cyanogen group. Cyanogen. Hydrocyanic acid. Cyanic acid and urea. Fulminates. Cyanuric acid. Sulphocyanic acid. Chlorides of cyanogen.

Amylaceous and saccharine substances. Fermentation. Alcohol, and its homologues. Ethers, simple and mixed. Oxidation of alcohol, Aldehyde and acetic acid, and their homologues. Anhydrides, simple and mixed. Compound ethers. Diatomic alcohols and their acids. Glycol and oxalic acid. Triatomic alcohols. Glycerine. Fatty and oily bodies.

Ammonia and its derivatives. Amides and amines: their classification.

Examples of natural alkaloids.

Principal colouring matters. Indigo and its derivatives. Examples of products formed by destructive distillation.

The chief constituents of the vegetable and animal organism, fibrin, albumen, casein, &c.

The chemical principles of agriculture.

The chemical principles of the process of nutrition and respiration in

the animal organism.

Text-books.—Graham's Blements of Chemistry, Miller's System of Chemistry, Fownes' Manual of Chemistry, Gregory's Outlines of Chemistry, Abel and Bloxam's Handbook of Chemistry, Galloway's Qualitative Analysis.

GROUP V.

GEOLOGY AND MINERALOGY.

This group is taken under two subjects.

Subject I.—Geology.

 The division of rocks into three great classes, aqueous, igneous, and metamorphic.

2. The mode of formation of stratified rocks,—marine strata—delta formations—freshwater beds,—the sign by which you can distinguish these.

3. The mode of occurrence of igneous rocks, ashes, lavas, and dykes.

4. Volcanoes and volcanic phenomena.

5. The theory of central heat.

6. Elevation and depression of land.

7. The ordinary mineral substances that enter into the composition of rocks.

8. Fossilization of organic bodies.

9. Table of geological formations, including those larger divisions absent in Britain.

10. Theory of metamorphism of rocks.

British Strata.

 Description of the Cambrian strata and Silurian strata, their lithological characters, disturbances and chief fossils.

Description of the old red sandstone and Devonian rocks, character and fossils. Origin of cleavage. Slate and slate quarries, building-

stones, limestones, and marbles.

3. The carboniferous limestone and coal measures. Character, fossils, and mode of formation. Origin of the coal of the coal-measures, and its mode of occurrence. Mode of occurrence of the ironstone of the coal measures. Various kinds of coal, and the relation of anthracite coal to disturbance of strata. Lime quarries, marbles, and building stones. Clay pits and potteries of the carboniferous strata. Fire clay. Alum shale.

4. The Permian rocks. Their strategraphical relations to the underlying strata, composition of rocks, fossils, and building-stones.

5. The new red sandstone (or Trias), its subdivisions, fossils, buildingstones, sand pits, rock salt, and brine springs.

 The Lias. Its subdivisions, chief fossils, building-stones, and other hydraulic limestones, and clay pits.

 Oolitic rocks. Subdivisions, leading fossils, building-stones. Limestones. Clay pits, and other economic products.

8. The Purbeck and Wealden strata. Origin, subdivisions, chief fossils, building-stones, and marbles. Ironstones and limestones. Clay pits.

 Cretaceous rocks. Subdivisions, lithological characters, fossils, building stone of lower greensand. Gault, its phosphatic nodules and general uses. Upper greensand, chalk, &c. Building stones. Origin and uses of chalk-flints.

 Eocene, or older Tertiary beds. Subdivisions, alternation of marine and freshwater beds, chief fossils, limestones and building stones,

clays for bricks and potteries.

11. Crag. Its subdivisions, chief fossils, phosphatic remains.

12. Disturbance and denudation of strata.

13. Unconformities, faults, and fractures.14. The causes of gaps in the succession of strata, or of breaks in the succession of life in time.

 Water-bearing strata, and underground drainage. Artesian and other wells.

16. British rocks in which ores of metal are found, and the general mode of occurrence of these ores in beds or lodes.

17. The rules that ought to guide the miner in sinking for coal and other minerals, when the beds in which they lie are concealed by over-lying and unconformable strata.

18. The occurrence of stream tin, gold, &c., in superficial detritus.

19. The chief differences in the nature and mode of occurrence of various formations in areas widely separated from each other.

Text-books.—Lyell's Principles of Geology; Lyell's Elements of Geology; Phillips' Manual of Geology; Jukes' Manual of Geology; Page's Introductory Text-Book; Page's Advanced Text-Book.

Subject II.—Mineralogy.

A. Instruction in this subject should commence with a distinct understanding of the characters by which minerals, properly so called, are to be distinguished from other inorganic substances, and of the position of this science in relation to the collateral sciences of physics, chemistry, and geology.

B. Crystallography, as the essential means of appreciating the forms naturally assumed by almost all inorganic bodies, must commence with the needful geometrical definitions, proceed to the grouping of the various crystalline forms into systems, consider the laws by which the derivation of one form from another within the limits of the same system is determined, and explain the combination of various simple forms in the faces exhibited by compound crystals. It is also important to study the deviations from regularity which are commonly presented in nature, and the methods of measuring those elements which remain constant.

c. The various kinds of aggregation exhibited by crystalline substances are also to be considered, especially with reference to masses of the useful minerals, and of crystalline rocks.

Next in order will follow the other physical characters of minerals;
 1st, in relation to their substance, as cleavage, fracture, hardness, and

specific gravity: 2ndly, in relation to the effects of light, as transparency, refraction, lustre, and colour; 3rdly, as to their electric and magnetic properties.

E. The chemical characters of minerals, and the most convenient modes of testing them; 1st, by aid of the blowpipe; 2ndly, by the

moist way.

F. Pseudomorphism, or the remarkable phenomena presented by minerals which have the composition of one mineral coupled with the form

of another.

G. The physiography or systematic description of minerals. This last division should include all the more remarkable varieties as well as species, and should take especial note of the modes and places of occurrence, as well as of the association of particular groups of minerals in certain veins or formations.

As text-books may be recommended—

Professor Ansted's Elementary Course of Mineralogy and Geology. London, 1856.

Nicol's Elements of Mineralogy. Edinburgh, 1858.

Dana's Manual of Mineralogy, 1851.

Bristow's Dictionary of Minerals. Longman & Co. 1861.

For more advanced students-

Brooke and Miller's Mineralogy. London, Longman, 1852. On Crystallography. Rev. W. Mitchell, in Orr's "Circle of the Sciences." London, 1856.

Dana's System of Mineralogy. 4th edition. Putnam, 1854.

Naumann's Mineralogie. Leipzig. Williams and Norgate, London.

Breithaupt's Paragenesis der Mineralien. Freiberg, 1849.

Haidinger's Handbuch der Mineralogie. Vienna, 1845.

When it is intended to teach this subject with special reference to the practical working of minerals, the physiographical part will be occupied more particularly with certain of the useful species and their associated substances, and the following works may be consulted:—

W. J. Henwood on the Metalliferous Deposits of Cornwall and Devon,

1843.

Bischof, Chemical and Physical Geology, translated by the Cavendish Society. 1854.

GROUP VI.

ANIMAL PHYSIOLOGY AND ZOOLOGY.

This group is taken under two subjects.

The field presented by Natural History is such an exceedingly wide one, that candidates are advised to confine their studies to the subjects enumerated below, and to master these as thoroughly as possible. And as in the Natural Sciences, the knowledge which is obtainable by mere reading is of very little value, candidates are particularly recommended to study nature for themselves, and to become personally acquainted with the primary facts of Biological Science. Thus in Physiology, the fundamental truths relating to circulation, muscular contraction, and nervous action, may all be readily exemplified by simple experiments upon the common frog; and in Systematic Zoology and Botany, the careful study of the structure of the animal and vegetable forms enumerated under the head of "types" will furnish a better conception of the animal and vegetable worlds than any amount of mere reading. Candidates will therefore be expected to be thoroughly and practically acquainted with the fundamental facts of Physiology, and in Zoology, with all the most important and distinctive characteristics of such of these typical genera as are illustrated by British species.

Subject I .- Animal Physiology.

Candidates should have carefully studied what is stated upon the subjects enumerated below in any good handbook of Physiology.

The general properties of living matter in respect of form, structure, and chemical composition. The meaning of the terms organ, organization, function, development. The difference between high and low organization. The division of physiological labour.

Why the living organism wastes. The difference between vital and putrefactive decomposition. The conditions and ultimate products of vital decomposition. The living body considered as a

machine performing a certain amount of work.

Why food is necessary. The difference between the food of plants and that of animals. The nature of the substances which constitute the food of man. The proximate chemical composition of milk, flour, meat, butter, potatoes, oatmeal, peas, rice, tea, coffee, beer, wine, and spirits; and the distinction of the proximate ele-

ments of each into nutritious and innutritious.

Why digestion is necessary, and how that function is performed in the human organism. The structure of the organs by which the following substances are formed, and their uses: saliva, gastric juice, pancreatic juice, bile. How the nutritious products of digestion are separated from the excrementitious residuum. The process of absorption. The means by which absorbed matters are conveyed to all parts of the organism. The structure and composition of human blood. The course and mechanism of the circulation.

Why the elimination of waste products is necessary. Excretion of carbonic acid. The mechanical and physical principles involved in the performance of the respiratory process in man. The excretion of urea and uric acid. The structure of the urinary apparatus, and the mechanical and physical principles involved in its action. The excretion of water as a part of the foregoing processes, and as effected by the skin. The structure and other functions of the skin. The mutual relations of the three great excretory apparatuses.

The conditions and sources of animal heat. The circulatory system of man viewed as a hot-water warming apparatus. The fuel

of the animal economy and its sources.

Animal mechanics. The human body as a locomotive apparatus. The structure of bones and joints. The structure and properties of muscle.

The structure and functions of nervous matter. The offices of the spinal cord and brain. The nature and mode of action of the sensory organs. Reflex action. Habit, as acquired reflex action. Instinct. Intellectual and emotional operations.

The nature of death, and the difference between general and local

death.

Local death:—lst, as a part of life; e.g. moulting, shedding of skin and teeth. 2nd, as opposed to life; e.g. sloughing and mortification.

General death:—Ist, as the natural conclusion of life. 2nd, as arising from disease or injury. Usual commencement of death in

the nervous centres, the heart or the lungs.

Reparative processes:—1st. Local, as exhibited in the reproduction of lost parts, healing of wounds, &c. 2nd. General, as shown in the reproduction of the individual by sexual generation. The origin and development of the embryo. The nutrition of the fectus and of the infant. Hereditary transmission, and the modification of physical and mental characters by education, as the basis of a rational belief in the possibility of human progress.

Subject II.—Zoology.

 Candidates should have carefully mastered the definitions of the sub-kingdoms, classes, and orders of the Animal Kingdom. They should understand and be able to explain the meaning of the-terms employed in such definitions; and they should be able to refer any specimens that may be placed before them to their proper classes.

2. Candidates should be able to give fair answers to questions relating to any or all of the following subjects, and they should be able to identify, refer to their proper orders, and if called upon to do so, describe, the objects enumerated in each section under the head of "types." In almost all cases these "types" are British animals.

By the term Natural History, of such and such an object, is meant such an account of it as is to be found in any standard modern work on Zoology.

i. The structure and mode of multiplication of infusorial animalcules and Foraminifera. The arguments which have been adduced for and against spontaneous generation. The luminosity of the sea, and the nature of the creatures which chiefly cause it. The natural history of the sponge of commerce. Types—Spongia, Vorticella.

ii. The meaning of the terms, zoophyte, coral, coralline. Natural history of the red coral of commerce. Common coral and coral reefs. What such reefs are, where they are formed, and how they grow. Natural history of the common freshwater polype, or hydra, and of the "jelly fishes," or "medusæ" of the sea. A sexual multiplication as exhibited by these creatures. Types—Hydra, Sertularia, Plumularia, Actinia, Corallium, Fungia, Oculina.

iii. Starfishes, sea urchins, and Holothuriæ; their structure and habits, and the metamorphoses which they undergo. Natural and

economical history of Trepang. Types-Uraster, Echinus.

iv. Natural history of the earthworm and the leech. Intestinal worms; their structure, propagation, and mode of entrance into animal bodies. Natural history of the Rotifera. Types—Lumbricus, Hirudo. Distoma, Tania, Ascaris.

v. Natural history of Crustacea. The lobster and crayfish, as exemplifying morphological and teleological laws. The process of ecdysis. Barnacles, acorn shells, and fish lice, as cases of extreme metamorphosis. The water flea as exemplifying asexual multiplication. Types—Cancer, Homarus, Astacus, Oniscus, Daphnia, Cyclops, Lepas, Balanus, Argulus.

vi. Natural history of spiders, scorpions, and mites. The "itch insect," centipedes, and millipedes. Types—Tegenaria, Scorpio,

Scolopendra, Julus.

vii. Insects; their mode of breathing as contrasted with that of spiders and crustaceans. The structure of their wings, and the mechanism of flight. The parts of the mouth and their modifications in beetles, bees, butterflies, bugs, and gnats. Structure of the eyes. Nature of stings, saws, and ovipositors. Natural and economic history of the blistering beetle, of the silk moth, of the bee, of the cochineal insect. Natural history of plant lice, of bugs, fleas, and lice. The house fly, blow fly, and gnat; wasps, humble bee, ichneumon flies; "black beetles," crickets, and locusts. The metamorphoses of insects. Types—Melolontha, Blatta, Libellula, Phryganea, Coccus, Aphis, Bombyx, Apis, Vespa, Musca.

viii. The characteristic peculiarities of the nervous, circulatory, respiratory, and locomotive organs of mollusks in general. Organization of "sea mat" (Flustra). Ascidians and "lamp shells"

(Terebratula). Natural history of fresh-water and marine mussels. Nature of mother of pearl. Formation of pearls. Pearl fishery. Natural and economical history of the oyster. Organization of snails and slugs, periwinkles, limpets, whelks. Development of the young of the latter. Nidamental capsules. Cuttlefishes and squing Paper nautilus. Pearly nautilus. The shipworm and Pholas. Mechanism by which mollusks bore. Types—Flustra, Ascidia, Terebratula, Unio, Mytilus, Ostrea, Pecten, Helix, Patella, Littorina, Buccinum, Chiton, Sepia, Loligo, Argonauta, Nautilus.

ix. Circulatory, respiratory, and reproductive organs of fishes. Their dentition. Natural and economical history of the lamprey, sprat, sardine, herring, pilchard, salmon, trout, eel, cod, haddock, sole, flounder, turbot, mackerel, tunny, sturgeon, skate, ray, dog fish, shark. Electrical fishes. Fishes which are capable of living in air. Pisciculture, or the artificial breeding of fishes. Types—Amphioous, Petromyzon, Syngnathus, Cyprinus, Perca, Accipenser, Lepidosteus, Raia, Spinas.

x. Natural history of salamanders, newts, frogs, and toads, Metamorphoses undergone by their young. Types—Salamandra,

Triton, Rana.

xi. Circulatory and respiratory organs of reptiles as distinguished from those of fishes and amphibia. Natural history of snakes, lizards, crocodiles, turtles, and tortoises. Tortoise-shell. Shedding of the skin in reptiles. Types—Coluber, Pelias, Anguis, Lacerla, Crocodilus, Testudo, Chelone.

xii. Organs of locomotion, respiration, voice, circulation, and reproduction of birds. Structure and mode of growth of feathers, Development of the fowl's egg. Artificial hatching. Migration, and instincts of birds. Natural history of domestic birds; of the ostrich, the apteryx, the penguin, and the dodo. Types—Falco,

Corvus, Columba, Picus, Phasianus, Ardea, Struthio, Anser.

xiii. Organs of respiration, circulation, and reproduction of mammals. Production and nutrition of their young. Placental and implacental mammals. Nature of milk and of the lacteal glands. Peculiarities in the dentition of mammals. Natural and economic history of the domestic mammals; of the ivory and fur yielding mammals; of seals; of whales. The hybernation and migration of mammals. Characters of the orders of mammals. Types—Cercopithecus, Vespertilio, Erinaceus, Lepus, Elephas, Sus, Cersus, Bos, Ovis, Felis, Phoca, Phocæna, Dasupus, Halmaturus, Ornithorhynchus.

xiv. The distinctive peculiarities of man. The characters of the principal races of mankind, and their geographical distribution.

Text-books for Physiology.—Carpenter's Animal Physiology, Bohn, 1859;
Dr. Kirke's Manual; Andrew Combe's Physiology applied to Health
and Education. For Zoology.—Dallas's Natural History of Animals;
Orr's Circle of the Sciences; Gosse's Manual of Marine Zoology;
Professor Green's Manual of the Protozoa.

GROUP VII.

BOTANY.

This group is taken under two subjects.

Subject I.—Vegetable Physiology and Economic Botany.

In this department the candidate will be expected to answer correctly questions on the following points:—

 The properties of the principal elements entering into the composition of plants. Carbon, oxygen, hydrogen, nitrogen, sulphur, phosphorus, chlorine, iodine, silicon, potassium, sodium, calcium, iron.

The composition and properties of the compounds forming the principal part of the structure of plants. Cellulose, starch, dextrine, sugar, fixed oil, gluten, albumen, caseine. The saline compounds forming the ashes of plants.

 The composition and properties of peculiar vegetable products. Volatile oils. Acids. Colouring matters. Alkaloids. Neutral principles.

Chlorophyll.

The origin and growth of the vegetable cell. The tissues of plants.
 Cellular tissue. Intercellular organs. Epidermal tissue. Hairs.

Stomates. Vascular tissue. Woody tissue.

5. The structure and functions of the organs of plants. The root. Spongioles. Absorption and excretion. Nature of vegetable food. The stem. Structure of Exogenous, Endogenous, and Acrogenous stems. The leaf. The forms of leaves. Exhalation. Stipules and bracts. The flower. Calycine, Corollal, Staminal, and Carpellary leaves. Development and nature of pollen. Ovules or seed buds. Vegetable impregnation. Embryo. Seed. Fruits; their nature and forms. The nature of the reproductive organs in flowerless plants.

 The composition and nature of vegetable substances used by man as food. Distinctions between heat-giving and flesh-forming foods. Structure and geographical distribution of plants yielding starch.

sugar, oil, gluten, albumen, and legumin.

Properties of vegetable substances used in the arts and manufactures.
 Vegetable secretions used as dyes.—Indigo, madder, logwood, red sanders wood, quercitron, alkanet, arnotto, gall-nuts, myrobolans.

8. Materials used in the manufacture of textile fabrics.—Cotton, flax,

hemp, coco-nut, jute, New Zealand flax.

 Principal forms of timber trees, and their uses.—Oak, mahogany, teak, pine, &c.

10. Nature of tanning principles and plants yielding tannic acid.—Oak-

bark, valonia, catechu, kino, divi-divi, betel-nut.

11. Gums, oils, and resins used in arts.—Gum arabic, benzoin, rosin, turpentine, camphor, essential oils, coco-nut oil, palm oil, other fixed oils, caoutchouc, gutta pertsha.

12. Substances obtained from the vegetable kingdom and used as medicines.—Opium, quinine, tobacco, jalap, scammony, gentian, aloes, rhubarb, senna, ipecacuanha, sarsaparilla, castor-oil, assafœtida,

myrrh, nux vomica, hemlock.

Text-books for Vegetable Physiology and Economic Botany.—Henfrey's Elementary Course of Botany; Van Voorst. Carpenter's Vegetable Physiology, edited by Dr. Lankester; Bohn. Schleiden's Principles of Scientific Botany; Bohn. A Manual of Structural Botany by M. C. Cooke. Archer's Popular Economic Botany; Reeve and Co. Lindley's Medical and Economical Botany; Bradbury and Evans.

Subject II.—Systematic Botany.

In this department the candidate will be expected to demonstrate the structure of plants from living specimens.

1. The distinctions between the three great classes of plants, Dicotyledons, Monocotyledons, and Acotyledons. Also of the groups Gymnosperms, Rhizanths, Dictyogens, Acrogens, and Thallogens.

2. The characters of the following orders of British plants should be mastered, and the typical genera recognized, and their structure

understood.

3. Algæ. The natural history and uses of sea-weeds. The microscopic structure of diatoms and desmids. Nature of the reproductive organs in this order. Types-Navicula, Desmidium, Conferva, Fucus,

4. Lichens. The natural history and uses of lichens. Structure of their

reproductive organs. Types-Graphis, Collema, Parmelia.

5. Fungi. The natural history of mushrooms, puff-balls, moulds, blights, and toadstools. Their uses in nature. Types-Agaricus, Bovista, Torula, Aspergillus, Morchella, Mucor.

6. Mosses. The nature of their reproductive organs. Types - Bryum,

Sphagnum, Funaria.

Nature of their rhizomes. Herbaceous and tree ferns. 7. Ferns. History of Development, and nature of reproductive organs. Types

—Polypodium, Hymenophyllum, Osmunda.

8. Graminaceæ. 'The history of grasses and their uses. Nature of the Useful plants of the order. Types—Phleum, flower in this order. Hydrochloa, Panicum, Agrostis, Arundo, Spartina, Avena, Festuca, Hordeum, Triticum, Secale, Nardus, Anatherum.

9. Cyperaceæ. Sedges. Types-Carex, Scirpus.

10. Liliaceæ. The lily tribe, its useful properties. Types—Tulipa, Ornithogalum, Muscari.

11. Amaryllidaceæ. The family of the narcissus, snow-drop, snow-flake.

Types—Narcissus, Galanthus.

12. Orchidaceæ. The orchis family. Structure of reproductive organs.

Types—Orchis, Goodyera, Malaxis, Cypripedium.

13. Amentaceæ. The family of the hazel, chestnut, oak, willow, birch, beech, poplar, and hornbeam. The uses of these plants as timber, Types-Quercus, Corylus, Fagus, Castanea, Betula, Myrica, Salix, Populus.

14. Urticacea. The nettle and hop tribe. Its relations to Moracea, Artocarpacæ, Cannabinaceæ, and Ulmaceæ. The nature of the stings of *Urtica*, and the bitter principle of the hop. Types—*Urtica*,

Parietaria, Humulus.

15. Euphorbiacea. The spurge family. Foreign forms and their uses. Croton, Cascarilla, Ricinus, Janipha. Apetalous and Polypetalous forms. Types-Euphorbia, Buxus.

The buckwheat and rhubarb tribe. 16. Polygonaceæ. Types—Poly-

gonum, Rumex.

17. Primulaceæ. The primrose family. Theory of the peculiar position Types—Primula, Lysimachia, of stamens.

18. Labiatæ. The dead nettle tribe. Peculiar properties of this order. Types-Mentha, Salvia, Thymus, Nepeta, Lamium, Teucrium.

19. Scrophulariaceæ. The scrophularia tribe. Nature of the poisonous properties of the order. Types—Scrophularia, Digitalis, Verbascum, Euphrasia, Veronica, Melampyrum.

The borage tribe. Peculiarities of their epidermis. 20. Boraginaceæ. Types-Cynoglossum, Borago, Echium, Myosotis Useful species.

Lithospermum.

21. Solanaceæ. The tribe of deadly nightshade, henbane, tobacco, and potato. Useful and poisonous species. Types—Solanum, Atropa, Hyoscyamus, Datura. Digitized by Google

22. Bricuces. The heath tribe. Its distinction from Epacridacea.

Types-Erica, Arbutus, Vaccinium, Pyrola, Monotropa.

23. Composité. The composite family. The number of species and geographical distribution. Structure of the sub-orders Asteracee, Oichoracee, and Cynaracee. Types—Tussilago, Aster, Inula, Gnaphalium, Bellis, Artemisia, Achillea, Carlina, Carduus, Cichorium. Leontodon, Lactuca, Crepis.

24. Stellate. The Stellate tribe. Its relation to Cinchonacea and Caprifoliaceæ. The properties and useful plants of Cinchonaceæ. Types—Galium, Rubia.

 Umbelliferæ. Umbel bearing plants. Character of inflorescence and flowers. Nature of fruit. Structure of cremocarp. Properties of the order. Types-Hydrocotyle, Sanicula, Eryngium, Apium, Sium, Æthusa, Œnanthe, Crithmum, Angelica, Pastinaca, Daucus, Torilis, Scandix, Conium, Coriandrum.

26. Cucurbitacea. Melon, cucumber, and gourd family. Useful plants of this order. Type-Bryonia.

27. Rosacee. The rose, apple, cherry, and plum tribe. Forms of the fruit. The useful plants of this order. Types-Prunus, Spiraa,

Fragaria, Rubus, Geum, Rosa, Cratægus, Pyrus.

28. Leguminosæ. The bean, pea, and clover family. Principal divisions of the family. Structure of the flowers and fruits. plants of the order. Types-Ulex, Trifolium, Vicia, Astragalus, Ornithopus.

29. Cruciferæ. Cabbage, turnip, and mustard tribe. Structure of the flowers and fruits. Useful plants of the order. Properties. Types— Nasturteum, Alliaria, Brassica, Sinapis, Armoracia, Iberis, Isatis,

Crambe, Cakile.

30. Papereraces. The poppy tribe. Properties and mode of collecting opium. Nature of fruit. Types—Papaver, Glaucium, Chelidonium.

The crow-foot tribe. 31. Ranunculaceæ. Structure of abnormal genera; Aconitum, Aquilegia, and Delphinium. Nature of poison in Types-Ranunculus, Clematis, Helleborus, Pæonia, Anemone.

Text-books for Systematic Botany .- Lindley's Vegetable Kingdom. For British Botany.—Bentham's Handbook of the British Flora, or Babington's Manual of British Botany.

GROUP VIII.

MINING AND METALLURGY.

This group is taken under two subjects.

Subject I .- Mining.

The Art of Mining embraces so wide a field of study that equal practical proficiency in its various branches is not to be expected; but those who wish to gain a general knowledge of it may be recommended to

direct their attention to the subjoined heads, viz. :

1. Geology and Mineralogy, more particularly those portions of the sciences which bear on the following subjects,—the nature and position in the earth's crust of the useful minerals, the classes of rock with which they are severally associated, the special character of heaves, throws, troubles, and all kinds of dislocation; the particular differences between beds and lodes, and their minerals, and the chief features of irregular repositories.

2. The methods of prospecting and searching at surface for ores and

other minerals.

3. Breaking of ground; the various implements employed, their form, dimensions, and weight; boring for shots; the various modes of firing charges. Heavy charges, how calculated and fired; rules for ensuring Digitized by GOOGIC safety.

4. Deep boring, under what circumstances applicable,—apparatus for;

description of varieties in use; lining of bore-holes.

5. Management and supervision; payment of men employed at mines, at surface and underground, varying in principle with the different classes of operation; reasons for tut-work or piece-work, and tribute or bing-tale under different circumstances. Calculations for cost of driving, sinking, tramming, &c.

6. Physical principles of ventilation; practice of mines where simple natural ventilation is employed; ventilation of large areas and of deep or complicated workings by guiding the natural current; artificial means, and their details, for promoting ventilation. Precautions to be

taken under specially dangerous conditions.

7. Illumination, of various kinds, their economy; safety lamps in all their best modifications; circumstances under which they should be

employed; precautions in their use.

8. Mechanical division of the subject. Strength of materials used in mines; human and horse power, principles and construction of machines to which they are applied. Hydraulic machines; construction of the water-wheels, turbines, and pressure engines most suitable to the various operations of mining. Steam engines, for pumping and for winding; arrangement and construction of the varieties most in use. Form and dimensions of boilers. Pumps employed in mines, mode of placing them; construction of the lifts; materials and details of the rods, setoffs, counterbalances, cisterns, and catches. Circumstances under which dams are erected in shafts or levels; mode of building them.

Tubbing of water from shafts; conditions under which it may be done; details of the operation with various materials, wood, brick, stone,

cast and wrought iron.

Rails, waggons, and tubs for underground conveyance; employment

of horses and of fixed steam engines for this purpose.

Raising of the mineral through the shafts; various methods in use; chains, ropes (of hemp or wire), their weight, &c. Details of the best application of drums, cages, guides, keeps, and safety doors. Pulleys and shaft frames or poppet heads; protection against over-winding; safety clutches, &c. in case of breakage of rope.

9. Opening of ground; quarries and open work; driving of levels, various dimensions and directions according to circumstances; sinking of shafts, inclined or perpendicular; advantages of either kind under certain conditions; means of securing levels and shafts by timber or by walling; details of the various methods. Driving or sinking in heavy or running ground.

10. Working excavations; plan of laying them out, and means of security to be adopted whilst they are kept open. This will include the stoping of metalliferous veins, and the various modifications of post and stall, long-work, &c., which are applied to stratified deposits.

11. Travelling in shafts; prevention of accidents by proper fitting and dividing; mode of placing ladders and sollars; lifting machine for men.

construction and advantages of.

12. Dressing of minerals. Arrangement of dressing floors. Construction of crusher and stamps; washing of coal; jigging, concentration, and separation of metallic minerals.

The student may be advised among other sources of information to

consult the following works :-

De la Beche's Report on Cornwall and Devon. Greenwell's Treatise on Mine-Engineering. Dunn on the Winning and Working of Collieries. Hedley on Colliery Working and Ventilation. Evidence before Committees of the Houses of Lords and Commons on Accidents in Mines. Reports of H.M. Inspectors of Coal Mines. Transactions of the Northern Institute of Mining Engineers.

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Subject II .- Metallurgy.

I. Introduction.

On certain physical properties of metals. Action of heat, specific gravity, crystallization, fracture, malleability, ductility, tenacity, conductivity of heat and electricity, opacity, lustre, colour. General considerations on metallurgical processes. Modes of occurrence of metals in nature, ores, reduction, smelting, roasting, liquation, slags.

II. Fuel.

General remarks, calorific power, calorific intensity, classification of fuels, wood, peat, lignite, coal, charcoal, coke, gaseous fuel and gas furnaces, charcoal burning, coke burning, typical varieties of coke ovens, comparison of fuels with respect to calorific power. This important branch of the subject is treated with much detail.

III. Refractory materials employed in the construction of furnaces, crucibles, &c.

Fire-clays British and foreign, crucibles of various kinds, plumbago and its application to crucibles, manufacture of crucibles, fire-bricks, silica and its applications, Dinas fire-bricks, sand and sandstones.

IV. Special Metallurgy.

Copper.—Compounds of special importance in the metallurgy of this metal fully described, such as the disulphide, oxides, &c., ores of copper, copper-smelting in reverberatory and blast furnaces, reactions occurring in the process, kernel-roasting, 'wet' methods, of extracting copper from its ores, assaying of copper ores by 'dry' and 'wet' methods,

ship sheathing.

Zinc.—In describing the metallurgy of zinc and the following metals, the same plan will be followed as in describing the metallurgy of copper, that is to say, the compounds of special metallurgical importance will be first considered in detail, as well as the reactions upon which the various processes of smelting essentially depend, and the construction of the furnaces will be fully explained. Ores of zinc, English, Belgian, Silesian, and Carinthian methods of extraction, assaying of zinc ores brass, its history, properties and manufacture.

Lead.—Ores of lead, lead smelting in the 'ore-hearth,' low blast and reverberatory furnaces, lead-fume and various methods adopted for its

condensation, assaying of lead ores.

Silver.—Ores of silver; smelting of silver ores with lead; cupellation; desilverization of lead by Pattinson's process, also by that of Parkes; treatment of argentiferous copper by liquation; extraction of silver; amalgamation, the old Freiberg method and the Mexican; Ziervogel and Augustin's 'wet' methods; treatment of argentiferous copper-regulus; alloys of silver and copper; standard silver; assaying of silver ores and alloys.

Gold.—Modes of occurrence of gold in nature; extraction by smalgamation and by smelting with lead; chlorine-water as a solvent for the extraction of gold from certain ores; separation of gold from silver or parting by nitric and by sulphuric acids; alloys of gold with the preceding metals; standard alloys; assaying of auriferous ores and

alloys.

Mercury.—Ores of mercury; extraction in the Almaden, Idrian, and Hähner furnaces; in retorts in admixture with reducing agents; assaying of the ores of mercury.

Astimony.—Ores of antimony; liquation of the native sulphide and its subsequent reduction by iron or other agents; alloys of antimony, type

metal, &c.; assaying of the ores of antimony.

Bismuth.—Mode of occurrence in nature; its extraction from ores

containing it by liquation; alloys of bismuth.

Nickel.—Ores of Nickel; modes of extraction, generally by a combination of 'dry' and 'wet' processes; alloys of nickel, especially those known as German silver; assaying of nickeliferous ores and alloys.

Cobalt.—Ores of cobalt; smelting and preparation of zaffre and cobalt colours, smalts, &c.; separation of nickel; assaying of cobalt

ores.

Arsenic.—Mode of occurrence in nature; arsenious acid or 'glass' of arsenic, generally obtained as a secondary product in the treatment of certain other ores, such as those of nickel, cobalt, &c.; modes of condensation of arsenical fumes; preparations of arsenical 'glass,'

Tis.—Ores of tin; smelting in reverberatory and blast furnaces; tin refining; varieties of tin in commerce; alloys of tin, with the preceding

metals, bronze, gun-metal, bell-metal, &c.; assaying of tin-ores.

Iros.—Malleable iron; steel; pig-iron; ores of iron, direct extraction of iron in the malleable state from the ore; smelting of iron in the modern-blast furnace; construction of blast-furnaces and blowing machines; economic application of the waste gases; conversion of pig into bar iron in open hearths and in the reverberatory furnace; manufacture of steel by various methods. This department of the subject will be treated at considerable length.

Various Metals.—Platinum and its associated metals; cadmium;

sodium; aluminium; tungsten; titanium; manganese.

LIST OF SCIENCE SCHOOLS AND CLASSES. May 1864.

Town.	Where held.	Teacher.	Secretary.	Secretary's Address.	Total No. under Instruc- tion in 1863-4.	Subjects taught and Number in each Class in 1863-4.
Aberdeen	Mechanics Institution -	Dr. Beveridge, D. Maver.	J. Sinclair	Mechanics Institute	88	26 Theoretical Mechanics: 9 in Geology; 6 in Vegetable Physiology and Eco-
Almondbury Bacup	King James' School Mechanics Institution	G. Jarmain - H. P. Meaden	Lewis Jones - T. Newbigging	Almondbury	81 22	nomic Botany. 16 in Inorganic Chemistry. 21 in Inorganic and 21 in Organio
Banbridge	Literary Mutual Im-	R. Tate -	A. Black	Banbridge	ន	Chemistry. 23 Geology; 23 Animal Physiology.
Banbury Banbury Banbury Banbury Banbury	British School Cherwell School Room Britannia Schools	J. H. Beale D. Pidgeon D. Pidgeon	J. Cadbury -	Banbury	€ 88 ≥	50 Animal Physiology; 30 Zoology; 8 in Vegetable Physiology; 40 Systematic Botany.
Banbury Bandon Belfast	Museum	T. Bossley R. Tate	Dr. S. Browne J. J. Murphy	Bandon College Museum, College Sq., East, Belfast.) \$	12 Geology; 13 Animal Physiology and 13 in Zoology; 35 Vegetable Physi-
Belfast	Royal Academical Insti-	J. S. Holden -	W. Shepherd-	13, Donegall Place,	3	ology; 35 Systematic Botany. 34 in Organic, and 34 in Inorganic
Belfast (Navigation)	rution.	G. Doran	R. Nesbitt .	Belfast	112	31 Mathematics, 43 General Naviga-
Birmingham	Birmingham and Mid-	C.J.Woodward	W. Oliver -	Beaufort Road, Edg-	16	47 Experimental Physics, Inorganic
Bollington	Large Sunday School	G. J. Snelus -	J. Brooke, jun.	Hollin Hall	ន	23 Acoustics, &c., 23 Inorganic Che-
Bolton	Holy Trinity Working Men's Institute.	J. Collins	W. H. Traice	124, Cheshire View, Pendleton.	8	89 Inorganic Chemistry; 34 in Vege- table Physiology and Economic
Bristol	Trade School	T. Coomber, H. Fulton, A. Leipner.	J. Wilkson -	Bristol	116	Dorany. 20 Acoustics, &c. 55 Inorganic, and 20 in Organic Chemistry. 26 Geology; 5 Zoology: 11 Verestable Physiology.
Burnley	Mechanics Institute	L. Clement	J. Sutherland	Post Office, Burnley	r,	8 Systematic Botany. 31 Experimental Physics; 63 Inorganic, 7 Organic Chemistry.

List of Science Schools and Classes—continued.

Subjects taught and No. in each Class in 1803-4.	23 in Inorganic Chemistry. 84 in Inorganic Chemistry. 12 Geology, and 12 Animal Physiology. 29 in Geometrical Drawing: 15 Mechanical and Machine Drawing: 5 Building Construction; 1 Animal	Physiology; 1 Zoology. 17 in Inorganic Chemistry. 17 in Inorganic Chemistry. 50 in Inorganic Chemistry; 10 in Geology. 25 in Animal Physiology, and 1 in Vegetable Physiology and Economic	18 Geometrical Drawing; 21 Mechanical Drawing; 2 Building Construction; 1 in Animal Physiology. 3 Magnetism, &c. 8 Acoustice, &c. 25 Inorganic, and 28 Organic Ohemistry; 5 Geology; 5 Animal Physiology; 5 Animal Physiology	siology; 5 Zoology; 12 Vegetable Physiology; 7 Systematic Botany; 8 Mining; 28 Metallurg; 4 Magnetism; 4 Acoustica; 22 In- organic, 22 Organic Chemistry; 6 Geology; 6 Animal Physiology; 6 Zoology; 18 Vegetable Physiology; 18 Systematic Botany; 22 Metallurgy, 15 in Inorganic Chemistry; 9 in Geology; 55 (4eometrical Drawing.
Total No. under Instruc- tion in 1863-4.	2 2 2 3	11 28 88	8 4	88 82 255 71
Secretary's Addrens.	Burnley 15, Water Street, Bury. Cheltenham Chestor	Chipping Campden, Gloucester. Christehurch Dudley Corseck by Dalbest- tis.	Crewe Drogheda	18, Anne Street, N.E., Dublin. Dudley 116, Seagato South Terrace
Secrotary.	B. W. Briggs - B. Bunting - H. J. Moore - Rev. James Harris.	Rev. J. Hamilton. Henry Jenkins J. Stokes J. Ferguson	T. Stubbs . P. J. Grey .	M. McPadden J. Skokes D. Bwing D. Brook
Teacher.	H. P. Meaden T. Ward - W. L. Notoutt E. A. Davidson	E.H.Macmillan W. Judd J. Jones Miss M. Mac-	E.A. Davidson J. Dowling .	J. Dowling . J. Jones . J. Kennedy . J. G. Jarmain
Where held.	Church of England Lite- ray Institution. The Bury Atheneum Young Men's Christian Association Mechanics Institute	National School Boom - The Townhall, Christ- church. Night School Room	Mechanics Institute -	Mechanics Institute Mechanics Institution Solool of Art Mechanics Institute
Тоwn.	Burnloy	Ohipping Campden Christohurch Corngreaves Corsock	Orewe Drogheds	Dublin Dudley

	139 16 Inorganic; 16 in Organic Chemis-	10gy; 40 Vegetable Physiology; 40 Systematic Botany; 14 Mining and	55 Magnetism, &c. 51 Inorganic Che-	- 15 Inorganic Chemistry; 15 Mineralogy.	- 18 Magnetism, and 18 Inorganic One-	. 51 18 in Acoustics, &c. ; 18 Magnetism, &c. 21 Inorganic Chemistry: 18 Aufmal	Physiology. 12 Inorganic Chemistry, and 12 in	Mineralogy. 17 17 in Inorganic Chemistry. Place, 67 in Geology, and 67 in Vegetable	Physiology and Economic 21 21 in Inorganic Chemistry.	71 in Mathematics, General Naviga- tion, Nautical Astronomy. Physical	Geography and Steam, 10 in Inorganic Chemistry.	Kid- 14 in Inorganic Chemistry.	14	Chemistry. 40 40 in Inorganic Chemistry.	287	n 128	Physiology and Zoology: 16 Vege-
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Glasgow.	Glasgow		Gloucester	Gunnislake	Haley Hill	Haslingden	Helston	Hereford -	So, Ramsden Street	Hull.	Hulme .	Green Place,	derminster. Hyde House,	Stourbridge. Mechanics Institu-	4, Jamaica N. Leith.	William Brow Street, Liverpool.	
lollan, jr.	Cunliffe		C. Y. Crawley	W. M. Philips	· sqo	· au	B. E. Cunnack	B. M. Lingwood W. Shepherd -	G. W. Rhodes	S. Wilson -	yton -	J. E. Stone .	ton .	ıke .	Rev. J. Thom-son.	E. B. Bright, J. Samuelson.	
J.M.C	18 18		C. Y.	W.M.	G. Gibbs	J. Binns	Ŗ. Ŗ.	R. M. 1 W. 8h	G. W.	S. Sei	B. Clayton	J. B.	T. Bolton	B. Blake	Rev. J	E.B.	
G.C.Foster, B.A. J.McClollan, jr. Dr. Buchanan.	J. Mayer,	•	W. Jeffery .	R. Pearce,	G. Jarmain.	H. P. Meaden	R. Pearce,	B. Tate	G. Jermain	Z. Scaping -	J. Hartley	M. W. Packer	M. W. Packer	G. Ward .	J. Bolam -	N. Samuelson, Dr. Colling- wood, E. H. Birken-	
versity	•		,	•	ollege	•	•	School	entific	King-	Christ Institution,	rfe -	•	ution-	•	William .	
- Andersonian University	Carlton Place		Blue Cost School-	,	Working Men's College	The Institute .	Mining School-	Proprietary School The Sullivan's School	Literary and Scientific	Society, Queen Street. Nautical Schools, King- ston-upon-Hull.	er Instit	Hulme. Mechanics Institute	Science School .	Mechanics Institution-	•	Free Library, W Brown Street.	
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мойнин	Glasgow (Mines.)		Gloucester	Gunnislake	Halifax	Haslingden	Helston	Hereford -	Huddersfield	Hull (Navigation)	Hulme	Kidderminster	Kinver	Leeds	Leith (Navigation) -	Liverpool	

List of Science Schools and Classes—continued.

Sultions taught and No, in each Class in 1843-4.	42 in Acoustics, &c. and in Geology.	30 Inorganio Chemistry.	trion Drawing 8 in Theoretical	Mechanics. 250 in Animal Physiology; 50 Zoology.	50 Magnetism, &c., and Animal Physiology; 25 Inorganic Chemistry; 90	32 Mathematics; 32 General Naviga- tion; 25 Nautical Astronomy; 10	24 in Inorganic Chemistry, 24 in Acousties, &c. 18 in Magnetism, &c. 30 in Inorganic, and 13 in Or-	30 in Inorganic Chemistry.	170 Geometrical Drawing; 84 Mechani- cal Drawing; 48 Building Construc-	Acoustics, &c., 110 in premium 25 Organic Chemistry, 160 Animal Physiology; 30 Metallury.	30 Inorganic and 35 Organic Chemis- try; 30 in Vegetable Physiology; 35	Systematic Botany. 2 Theoretic Mechanics; 2 Acoustics, &c., and Magnetism; 21 Inorganic Chemistry. 9 Animal Physicians.	12 Vegetable Physiology. 15 in Inorganic Chemistry.
Total No. under Instruc- tion in 1868-4.	3	S	20	920	8	2	23	8	2		2	ä	15
Secretary's Address.	53, Squirries Street	32, Horton Square,	24, Norfolk Road, Dalston.	28, Dalston Terrace,	418, Shaftesbury Street, New North	Kond. Sailors' Institution, Shadwell.	Loughborough 88, Mill Street, Mac- olesfield.	38, Mill Street, Mac-	Mechanica Institu- tion,		Town Hall, Salford	Cathedral Schools -	Peel Street, Brougham Road.
Becretary.	J. H. Halliday	G. Phillipson	W. H. Hoskins	C. Whittard .	J. Ross	T. A. Fieldwick	C. H. Capp J. Brooker	J. Brooker -	A. Jarrett .		W. Noar	Rev. G. Hunt- ington, M.A.	J. Pinder
Teacher.	B. Simpson -	P. G. Corbin -	R. Bithell .	A. Jones	J. Howard .	•	J. Scott - G. J. Snelus -	J. Chadwick -	J. Angell		F. Hudson .	J. Collins	G. Jarmain .
Where held.	St. Matthew's National Schools, Church Row,	Bethnal Green. St. Thomas, Charter-	British School Room -	Cross Street, Islington,	Lower Islington Public School, Windsor	Street, Lower Boad.	The Town Hall . Christ Church School, and Mechanics Insti-	The Modern Free School	Mechanics Institution -		68, Corporation Street -	Cathedral School, Todd Street.	The Mechanics Institu-
Town.	Bethnal Green	St. Thomas, Char-	Kingsland	Islington	Islington	Shadwell (Navi-gation).	Loughborough .	Macclesfield	Manchester		Manchester	Manchester	Marsden

7 7 7	Chemistry, 24 in Inorganic Chemistry and 23 in	42 in Inorganic Chemistry.	9 in Animal Physiology. 38 in Acoustics, Light, and Heat, and	in magnetism and Electricity. 17 in Inorganic Chemistry. 52 in Acoustics, &c., and in Inorganic	Chemistry. 146 in Practical, Plane, and Descriptive Geometry: 92 in Mechanical	and Machine Drawing; and 54 in Building Construction. 30 in Practical, Plane, and Descriptive	Geometry. 16 in Inorganic and 9 in Organic	al, Plane, and De	Geometry. 7 in Inorganic Chemistry. 18 in Inorganic Chemistry. 38 in Animal Physiology.	23 Geometrical and 34 Mechanical Drawing; 24 Inorganic and Organic	Chemistry; 11 Geology. 20 in Inorganic Chemistry.	53 in Geometrical and Mechanical	Drawing. 12 in Mineralogy.	12 Geometrical; 22 Mechanical Draw.	45 in Inorganic, 8 in Organic Chemistry; 22 in Geology; and 23	Animal Physiology. 8 in Theoretical Mechanics; 11 in Acoustics, Light, and Heat.
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West Nowlands, Middlesbro Middleton Post Office, Burnley	South Crosland,	18, Morley Street,	Park Street, Newton Model School, New-	North Church Street Oldcastle, County	Oldham -	Oldhem	Post Office, Burnley	New Street, Pains-	Queensbury Rawtenstall Redditch	Town Hall, Salford -	Mechanics Institu-	Upton Grove, Slough	Tolkulla, Scorrier,	60, Church Gate -	Bowbridge House, Stroud.	Tintwistle .
W. Taylor Bev. J. R. Walker. J. Sutherland	B. Bentley .	A. Carse -	R. Benbow - M. Harbison -	R. Thurlow B. O'Neill .	Rev. D. M. Alexander.	S. Ingham -	J. Sutherland	J. M. Skinner	G. Turner T. Thomas V. Milward	W. Noar	J. Pickles -	J. Chapman	E. H. Hawke,	S. Robinson -	S. J. Dudbridge	P. Taylor .
W. Crossley - J. Collins - L. Clement -	G. Jarmain	W. Johnston -	W. Gunn W. H. Greer	Dr. T. Wilson A. Smyth, J.	J. Mellor	T. Butterworth	L. Clement	M. Pullen	J. Halliday - H. P. Meaden T. W. Shore -	C. O'Neil and J. Plant.	G. Jarmain	J. Dorrell	R. Pearce	W. Hudson	W. Vick and M. M. Pullen.	W. Cooper
Mechanics Institution - National School - Mechanics Institution -	Mechanics Institution -	Mechanics Institution -	National School - National Model School -	Mechanics Institution -	Parish Church Schools -	Literary Institution -	Trades Hall	Free Sohool	Queensbury School Mechanics Institution - Literary and Scientific	Working Men's College	Mechanics Institution -	Mechanics Institution -	The Institution	Mechanics Institution -	Lecture Room, King Street.	National School -
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Middlesboro' - Middleton Nelston in Marsden	Netherton	Newcastle-on-Tyne	Newtown Newtownards	Nottingham Oldcastle	Oldham	Oldham	Padiham	Painswick	Queensbury Rewtenstall Redditch -	Salford	Slaithwaite	Slough	St. Day	Stockport	Strond .	Tintwistle

List of Science Schools and Classes.—continued,

Town.	Where hold.	Teacher.	Secretary.	Secretary's Address.	Total No. under Instruc- tion in 1863-4	Subjects taught and No. in each Class in 1863-4.
Upton St. Leonards Walsall	School Room Grammar School, Lich-field Street. Model School	U. J. Davies - J. Dowling -	Bev. JohnBetts Bev. A. C. Irvine. F. Bardley	Parsonage, Upton St. Leonards. Grammar School	15 55 51	31 Vegetable Physiology and Boonomic Botany. 50 in Inorganic Chemistry. 19 in Geology.
Wigan	Mining and Mechanical School.	٠ 4	M. W. Peace		311	76 Geometrical and Mechanical Drawing; 5 in Theoretical Mechanics; 2 Applied Mechanics, Acoustics, &c., and Magnetism, &c. 29 Inorganic
Wolverhampton • Wolverton •	Working Men's College and Christian Insti- tute.	J. Jones and J. Hough. Rev. F. W.	J. N. Langley, M.A. J. Orton	Mowbray House • Wolverton • •	7 7 88	and 1 Organic Chemistry; 23 Geology; and 20 Mining. 14 Inorganic Chemistry. 19 Geometrical, 19 Mechanical Draw- ing 19 Mechanical Draw-
Woolwich Yarmouth (Naviga-fion).	Mechanics Institution	Kone. Tr. Jones and W.T. Rowden.	B. McGrath - M. Butcher -	Royal Gun Factory, Office. Navigation School -	12 841	nig; 10 magneram, ec; 20 morganic Chemistry. 46 in Geometrical, 46 in Mechanical Drawing; 15 in Magnerism, &c. 81 Mathematics; 71 Nautical Astro- nomy; 71 General Navigation; 11 Physical Geography.

TABLE of Honorany Diplomas granted without Examination.

Name.	Address.	o ge	Group I. Geometrical Drawing, &c.		Group II. Mechanical Physics.		Group III Experi- mental Physics.	H tes	Group III. Group IV. Experimental Chemistry. Physics.		Group V. Geology and Miner- alogy.	ان يو خ	Group VI. Animal Physicology and Zoology.	Sind to	Group VI. Group VII. Group VIII. Animal Physiology Physiology and And Roone- Zoology and Rone- Zoology mic Botany. Metallurgy.	H SS H	Mining and Metallurg.	VIII dang
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Brazier, Professor - Abe	Aberdeen · · ·	:	:	:	:	:	:	:	ışt	1st	:	:	:	:	<u>:</u>	:	:	:
Collingwood, Dr Live	Liverpool	:	:	:	:	:	:	:	:	:	:	:	#	1st	1st 1.	14	:	:
Carter, B. B Stro	Strond, Gloucester-	:	:	:	:	:	:	:	:	:	:	:		*	:		:	:
Pepper, John H Poly	Polytechnic Institute, Regent St., London.	:	:	:	:	:	:	:	#	1st	:	:	:	:	· :	:	:	:

TABLE Showing CERTIFICATES held by SCIENCE TEACHERS.

Revised by the Examination of November 1864.

The asterisk before a Name indicates that the Teacher was Certificated before the Minute of 2nd June 1859 came into operation.

·		D OF	Group I. Geometrical Drawing, &c.		Group II. Group III. Group IV. Mechap. Experi. Chemis- ical mental try. Physical physical	I. Gr	roup II. Experimental	G G	froup IV. Chemis- try.	I	Group V Geology and Miner-	Group Animal Physical ology ar		Group VII. Vegetable Physiology and Econo-		Group VIII. Mining and and Metallurer	A VIII
Name.	Address.	ő	Subject.		Subject.		Subject.		Subject.	- Se	Ruogy.	Subject.	Subject.	Subject.		Subject.	. j
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Abbott, Joseph Alldread, Edwin Allen, Alfred H. Allott, James Allen, Willian	Collegiate Institution, Liverpool Training College, Battersea 14, Fernley Place, Glossop Road, Sheffield National School, Rusbon, North Wales Grammar School, Moulton, near Spalding	::::			::::	1st	# : :# :	t 1st 2nd 1st t 2nd t 2nd 3rd	2nd 1st 2nd	3rd	2nd		. ::::	::::	::::	:::::	:::::
Arthey, William Atkins, Edward Atkins, George Bailey, Edward J.		:::::	:::::		ist 3rd	2nd 3rd	:: # ::	d 2nd 2nd 2nd	2nd	:::::	:::::	1st	:::::	:::::	:::::	:::::	2nd
Baldock, John H. Bannister, Richard Barret, E. Bartley, George C. T. Beale, John H.	14, Claremont Place, North Brixton, London 7, Coulson Street, Chelsea 31, Gloucester Street, Regent's Park Baling Science School, Banbury	:::::	:::::		:::::	:: :: :: :: :: :: :: :: :: :: :: :: ::	g	1st 1st 1st 3rd	1st 1st 1st	: : : ব্ল :	:::::	:: 1st 2nd	3: : :	18t : : :	:::::	:4:::	:::::
Beetty, John Beesley, Thomas Bentley, Buxi Berriman, John Beveridge, Robert .	Endowed School, Oldcastle 5, High Street, Banbury Kirkhedon Training College, Battersea 2, Upperkirkgate, Aberdeen	:::::	:::::		:::::	3rd Snd	a 2nd	d 1st 3rd 2nd	18t	2nd :: 1st	:::::	::::	185	1st 	1st :: 1st	::::	:::::
Birkenhead, Edward H.	•	:	:		1st 1st		18t		Snd	1st	2nd	lst	1st	:	:	1st	:
Bithell, Richard .	Orphans' Home, Halifax	Snd	<u>:</u> :	=	<u>:</u> :	_	2nd 2nd	d 1st	<u>:</u>	<u>:</u>	:	2nd 2nd	Pug Dug	Snd 2	:	:	:

Blackwell, C. A. Blears, William Bocharoff, Alexis	National School, Owston, nr. Bawtry Training College, Westminster 17, Elton Street, Lower Broughton, Man-	:::	:::	:::	:::	=======================================			Srd ::		:::	:::	:::	:::	:::	:::	:::
Bowen, Edward -	86, Boundary Lane, West Derby Road,	:	<u>:</u>	<u>:</u> :	<u>:</u>		2nd 2r	S nd	<u>:</u> :		:	:	:	:	:	:	:
Bownes, John Breakwell, William Brears, William	Dreppon, Calne, Wilts	:::	:::	:::	: :	::E :::			2nd		:::	:::	:::	:::	:::	:::	:::
Briggs, James Alfred	London. Mechanics' Institution, Chancery Lane -	:	:		<u>:</u>		2nd 2n	Snd .	<u>:</u> :		<u>:</u> :	:	·:	:	:	:	:
Bright, William	17, Bute Street, Cromwell Lane, Bromp-	:	:	:	<u>:</u> :	<u>:</u>	:	_	3rd :		<u>:</u>	<u>:</u>	:	:	:	:	:
Brown, Moses Brown, W. J. Bryant, John Burchill, Samuel H.	KELL	::::	::::	::::	lat 2	and Sind	70	75	2nd		::::	::::	::::	::::	::::	::::	::::
Burns, William Button, John Cattell, Thomas E. Oausier, Jno. Wm.	St. John's Hill, Wandsworth 8, Newton Terrace, Rochester Training College, Westminster National School, Cottesmore, Oakham 13, Hindon Street, Pimlico	2	::::	:::::	3rd	1st ::::	ਰ ਰ	ਰਰ ਰ	1st 1s	49	:::::	:::::	:::::	2nd	::: g:::	:::::	:::::
Chadwick, John Chalk, Ellen M. Chalk, Frank . Clapp, Elizabeth M.A. Clark, Albert Chas	Modern Free School, Macelesfield - 3, Heasman Terrace, Victoria Park Birkbeek School, Kingsland National School, Kalsbury -	:::: 13t	:::::	t	:::::	:::::	:::::		grid ::	64	<u>::::</u>	1st 2nd 2nd	:::::	:::::	:::::	:::::	::::
Clement, Leonard .	Es	:		:	:	: 1st	_	2nd 2	2nd 1	1st 21	2nd	:	:	1st	.:	:	:
Clough, James C. Cockman, Abraham - Coles, Ferdinand Collins, John	Grammar School, Dedham . National School, Grantham . National School, Grantham . Shaplole Street, Chelsea . Cathedral School, Manchester .	::::	::::	::::		3s	7	7	Sudden St.:	75	:::: <u>:</u>	:::8	::::	:::\$::::	::::	::::
Collins, Joseph H. Conder, John Constable, John Cook, Chas. Lukey Cook, Thomas H.	86. Denmark Grove, Barnsbury Park St. Anne's School, Wandsworth Brooke's School, Thorme, Doncaster National School, Beckley, Oxford Horsham Road, Dorking	:: %::	i.i.	:::::	:: : : : :	:::::	:::::		2nd 3rd		:::::	:::::	:::::	:::: દ	:::::	:::::	
Cooke, Mord. Cubitt	6, Montague Place, Kentish Town	:	:	-	:	<u>:</u>	<u>:</u>		<u>:</u>		<u>:</u>	<u>:</u>	<u>:</u>	Ħ	1st	:	:

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Table showing Certificates held by Science Teachers—continued.

		Group'I.	Group II.	Group III.	Group III. Group IV.		Group VI.	Group VII.	GroupVIII.
Name.	Address.	Geometrical Drawing, &c.	Mechan- ical Physics.	Experimental Physics.	Chemis- try.	Geology and Miner- alogy.	Animal Physi- ology and Zoology.	Vegetable Physiology and Econo- mic Botany.	Mining and Metallurgy.
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*Coomber, Thomas Cooper, Charles Cooper, William Corbin, Pennel G.	Trade School, Bristol St. Mark's College, Chelsea National School, Tintwistle, Manchester Training College, Battersea	::::	3rd 1st	1st 1st 3rd	2nd 2nd 3rd 2nd	::::	::::	::::	· · · · · ·
Cover, John L Crafts, Thomas - Craven, Joseph Crawley, Samuel - Cribbin, Thomas	National School, Weeton Harewood, Leeds Godmanchester, Hunts Staveley, Chesterfield Proprietary School, Hereford Birkbeck School, Peckham	:::::	5	2nd	::::::::::::::::::::::::::::::::::::::	:::::	žnd	:::::	:::::
Crossley, William Davidson, Ellis A. Davis, Uriah J. Davison, William Day, Thomas N.	Mechanics' Institute, Middlesboro' School of Art, Chester Upton St. Leonardis, Gloucester 127, Stantombury, Wolverton Quaker Street Schools, Spitalfields	1st 1st 1st	:::::: :::::::::::::::::::::::::::::::	1st	2nd 1st 3rd 2nd	:::::	2nd 3rd 1st	::::::::::::::::::::::::::::::::::::::	:::::
Deverell, W. T. Dixon, Frederick T. Doherty, Joshus J. Douglas, John C. Dorrell, Chas. Fred.	Buenos Ayres, South America Model School, Bailieboro, Co. Cavan, Ireland Mechanics' Institution, Chancery Lane 2. Chandos Street, Covent Garden	: : : : : : : : : : : : : : : : : : :	:::::	1st ist ist 2nd 1st	3rd	:::::	::::::::::::::::::::::::::::::::::::::	:::::	:::::
Dorrell, Henry B. Dorrell, John Dowling, James Dowling, John Duffy, John N.	Wellington Road, Slough Wellington Road, Slough Model School, Waterford 2, Upper Buckingham Street, Dublin County School, Leicester	and snd	3rd	:::::	2nd 2nd	1st Snd	:: :: :: :: :: :: :: :: :: :: :: :: ::	 1st 1st	: : : : : :
Dunn, Henry Bardley, Francis Bacterby, William Beterby, William	Training College, Westminster Waterford Trinity Schools, Ripon St. Mark's College, Chelsea	::::	2nd 2nd	ist ist	3rd 1::	::::	::::	::::	::::

Edwards, Thomas	2 Victoria Street, Govan, vid Glasgow -	:	:	:	:	: :	<u>:</u> :	=	: :	=	:	3rd	:	:	:	:	:
Betcourt, Charles Byers, Henry Farmer, James H. Farncomb, Edward Finlay, Alex. W. A.	28, Halsey Street, S.W. Charles School, Plymouth 119, Cumberland Street, Glasgow 16, Prior Street, Greenwich 52, India Place, Edinburgh	:::::	:::::	:::::	:::::	:::::	Srd Snd		1st 1si 2nd	##	:::::	:::%	srd 2nd	3rd 3rd	:::::	:::::	:::::
Ford, Benjamin Foister, John S. Foster, Benjamin	Bolckow's Iron Works, Middlesboro' St. Mark's College, Chelsea Wesleyan Training College, Horseferry	:::	• • • •	:::	:::	:::	3rd		::: :g::	:::	:::	3	:: :	:::	:::	:::	:::
Fryar, Mark Fulton, Hugh	Andersonian University, Glasgow - 22, Brunswick Street, Buston Road, London	;:	::	::	: :	::	<u>::</u> ::		:: ::	Sud	d 2nd	2nd	1st	::	::	tst:	::
Gatehouse, James W. Gates, George Gayne, Arthur J. Gibbs, John Gliedhill, Joseph	Training College, Battersea St. Mark's College, Chelsea Trade Sehool, Bristol Baddow Road, Chelmsford	:::;:	· · · · · · ·	::::	:::::	. <u></u> 	:::: : :		Sind		:::::	:::::	:::::	:::::	::::b::	:::::	:::::
Goffin, Bobert Goodwin, W. H. Grant, William Greenstreet, Wm. A. Greenwood, Aaron T.	Endowed School, Exton, Oakham Marquis of Salisbury's School, Hatfield Wesleyan School, Belby Evesham Training College, Westminster	:::::	:::::	.:. : g:	:::Þ::	:::::	3rd	70 70	p. p.p.p.		:::::	ਲ : : : :	:::::	:::::	:::::	:::::	:::::
Greer, William H. Grove, John W. Grugeon, Alfred Gunn, William - Halgh, Thomas R	Newtownard's District Model School Green-coat School, Hertford S, Radhor Terree, Brownlow Ed., Dalston Chipping Campden, Gloucestershire Training College, Westminster	.:::::	:::::	:::::	:::::	81 · · · · · · · · · · · · · · · · · · ·	2nd 2n 3rd 3rd 1st 2nd	ਰਜ਼ ਰ			:::::	: : : : : : : : : : : : : : : : : : :	:::gud	:: pug	:: 5nd	:::::	::;::
Halliday, John - Handa, Jonathan G Hancock, John - Hargreaves, John - Hartley, Joseph -	Queenbury Schools, near Halifax - Training College, Battersea - 17, Riding House Street, Laugham Place - National School, Goldsboro', Knaresboro', 89, Bridgewater Street, Manchester -	:::::	:::::	:::::	:::::		3rd	75	Srd Srd Srd Srd Srd Srd Srd Srd	sud Sud	:::::	:::::	::;::	:::::	:::::	:::::	:::::
Hetherinston, Juo.H. High, William B. Holdcroft, Herbert Holden, John S. Holt, George	Windsor Road, Slough Blue Coat School, Cirencester Training College, Westminster Holywood, Belfast Wesleyan Training College, Westminster	# : : : :	:::::	:::::	:::::	:::::	. : : : : : : : : : : : : : : : : : : :		3rd 3rd 1st 2nd	grad 1st	:::::	:::::	:::::	:::¤:	::: # :	:::::	:::::
Honey, Robert	Cowper House School, Huntingdorf	:	:	:	:	<u>:</u>	<u>:</u>		<u>:</u> :	<u>:</u>	:_	Tet .	:	:	:	:	;

Table showing Certificates held by Science Teachers-continued.

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Name.	Address,	Geo	Geometrical Drawing, &c.	رد به ا دو چها	Mechan- ical Physics.		Experimental Physics.		Chemis- try.		Geology and Miner- alogy.		Ammal Phosi- ology and Zoology.		Vegetable Physiology and Economic Botany.	Mining and Metallurgy.	ing d lurgy.
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Hotchkin, Tycho E Hough, Joseph	Somerby, nr. Oakham Wrottesley Observatory, near Wolver-	::	::	::	3;	==	. <u>::</u>	lst 	st 3rd	::	::	gud :-	<u>::</u>	::	::	::	::
Howard, John - Hudson, Fearnside -	Lower Islington Public School, London - 68, Corporation Street, Manchester -	::	::	::	::		2nd 3r	3rd 2r 3rd 1s	2nd 1st 1st	::	::	grd :	2nd	lst:	 2nd	::	::
Hudson, Washington Hudson, J. Schoffeld Hudson, William Hurst, Edwin Hurst, Wm. F.	Earle Foundry, Manchester National School, Brenchurn-morpeth Colet National School, St. Thomas s, Stepney St. Mark's College, Chielsea Middle School, Leicester	2nd	1st	2	2nd 2nd 3rd	.: st	:: B::		srd	:::::	:::::	<u>:::::</u>	:::::	:::::	:::::	:::::	:::::
Ives, Wm. Field Jackson, Robert Jackson, William Jarmain, George Jeffrey, Walter	St. John's School, Limehouse St. Mark's College, Cholsea Hunsingore, near Wetherby East Parade, Huddersheld Blue-coat Hospital, Gloucester	:::::	:::::	:::::	£nd		3rd 1st 1st		2nd ist ist 3rd 3rd	: ::t	:::::	:::::	:::::		:::::	:::::	:::::
Johnston, William Jones, Alfred Jones, Edward Jones, Elix. S. L. Jones, John	101, Percy Street, Newcastle-on-Tyne British Schools, Kingsland Training College, Westminster Halton, Hastings St. Thomas' Charterhouse Schools	:::::	:::::	:::::	: : : : : : : : : : : : : : : : : : :		<u> </u>		::::::::::::::::::::::::::::::::::::::	£ ::::	:::::	:# : : : 	::: :::	srd ::	:::::	:::::	:::::
Jones, John Jones, Thomas Jones, Bichard Judd, John W.	The Trindle, Dudley Woolwich Skyral Gun Factories Woolwich St. Mark's College, Chelsea 2. Brixton Rise, Brixton Hill, London High Street, Christchurch, Hants	: £ : : :	:::::	:::::	pug		75 43		3rd 3rd 2nd 1st 2nd	2nd 3rd ::	:::‡::	2nd	:::::	1st : :	srd	:::::	:::::
Kelly, James J.	Gladsmuir Parish School, East Lothian	<u>:</u>	 :	= :	: - :	_	2nd Sr	3rd 3r	3rd	<u>:</u>	<u>:</u>	:	_:	<u>:</u>	:	:	:

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17, Springfield, Dundee St. Mary's School, Putney Training College, Westminster County School, Lefcester Wesleyan College, Westminster All Sainta' School, Preston 22, Upper Park Street, Gifton St Mark's College, Chelsea Ohnrich School, Gorge Town, Demeara Wesleyan College, Westminster		St. Thomas, Charterhouse Schools Trafalgar, Salisbury 100, Upper Thames Street, B.C. Mechanics, Institute, Aberdeen 50, Gloucester Street, Glasgow	Secular School, Carlton Place, Glasgow 89, Upper Wellington Street, Dublin Campden, Gloucesteralire Kirtonholme, Kilmarnook	George Street, Hashingden - Science School, Oldham St. Mary Tavy: Tavistock Training College, Westminster Training College, Battersea	7, London Road, Liverpool St. Mark's College, Chelsea Auchenheath Navigation School, Shadwell Camborne House, Ventnor, Isle of Wight	Working Man's College, Halifax - 15, Salishury Street, Lissen Grove - 1894. High Street, Cheltenham - Working Man's College, Salford -	-
alah	ibald paret	• • • • •		ei . g	H	្កាំ	
Kenby, John Kerby, Itaao King, Charles King, Thomas Kitchen, William Lee, Robert Lidpuer, Fred. J. A. Lines, John Lines, John Lingd, William	McCallem, James McFarlane, Archipald Mackrell, Isaac Macomish, Margaret Manser, William	Martin, Villiam Martin, William Mason, James Maver, David Mayer, Elizabeth	Mayer, John Mayne, Arthur J. McIvor, Alexander McMillan, Edw. H McRae, James	Meaden, Henry P. Mellor, James - Merrifield, John Millican, William Moore, Thomas	Morton, George H. Moss, Amos Muir, Robert Nelson, Robert J. Nicholson, William	Noble, John - Northey, John - Nofcutt, William L. O'Neill, Charles	gle

Table showing Certificates held by Science Teachers-continued.

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Name.		Address	Oeo Drag	Geometrical Drawing, &c.	ाहु उं	Mechan- ical Physics.		Experi- mental Physics.	मंत्रह	Chemis- try.		Geology and Miner- alogy.		Animal Physi- ology and Zoology.		Vegetable Physiology and Economic Botany.		Mining and Metallurgy	Ď
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Orkney, Daniel C.		Free Church School, Jamestown, Dumbar- tonshire.	:	:	:	:	<u>:</u>	:	:	g pug	3rd	:		<u>:</u> :		:		:	
Packer, Matthew W. Pacce, John Patchett, Isaac - Pearce, Eichard Pearce, William -	≱	National School, Kinver, Stourbridge Green-coal School, Huntingdon Queenshead Schools, Halifax Royal Institution, Truro Maber Lodge, Portswood, Southampton	;:;::	::::;	:::::	:::::	:::::		Sind Sind	Srd Snd Srd Snd Snd Snd Snd Snd Snd Snd Snd Snd Sn	7	· : : : : : : :		2nd 1st			:::::		
Peersall, T. J. Pepper, Charles Perry, George W. Pidgeon, Daniel Phillips, Harvey		Loudon Mechanics' Institution St. Mark's College, Chelsea - St. Michael's Schools, Pimlico Banbury 5, Robert Street, Milford Haven	;;;;;	· : : : : : : : : : : : : : : : : : : :	:::::	.달···			:::::	2nd 3rd	:::::	:::::		:::::	:::::	:::::	:::::	• • • • • • • • • • • • • • • • • • • •	
Pike, Robert W. Pitt, Robert Plant, Edmund C. Plant, John Prosect, William	• • • • •	Birkbeck Schools, Bethnal Green. Normal College, Cheltenham Royal Museum, Peel Park, Salford Dean Row, near Wilmslow	:: .	:::::	:::::	:::::	:::::	Bud : : : :	# : : : :	S	:::::			1st 1st std	<u> </u>	:::::	:::::	· · · · · · · · · · · · · · · · · · ·	
Pullen, Moses - Puckett, Joseph -		National School, Painswick, Stroud 14, Goldington Street, St. Pancras Road,	End :	::	::	2nd	P :	gud :	Snd.	::		:: Sud Sud		:: #:	# :		::	.:.	
Radford, Arthur Baimbach, David W. Restchlous, HenryA.		Art, Birmingham ton Hill, St. Neots	: ; ;	. .	: ist	. : gr	:::	puz	:::	:::		3rd 3rd			:::	:::	:::	:::	
Redgrave, Gilbert R. Ricka, George Rigg, William		18, Hyde Park Gate South		;;;	:: 1st	- 	:::	:::	:Z:	Srd Srd Srd Srd		:::		2nd 3rd	:£:	.::	:::	:::	
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Ripley, Henry J.	Training College, Battorsea	•	:	:	-:	:	=	-	-				=	-					
	minute Class School, Bagenot,	- sarres	:	_ :	:	_	-	:	2nd 1	1st 2	2nd	:: ::	:	:	::	::	::	::	
Robertson, John	Milton Established Church Schools, Glassow.	Sessional	:	:	:	<u>:</u> :	-	Sud 2	gud 5	2nd	<u>:</u>	<u>:</u>	:	:	:	:	:	:	_
Rowden, William T.	Woolwich		1st	1st	Bnd	18t 2	End	Snd		18t .	- 22	2nd 1st	:	:	:	:	2nd	18t	
Bowland, Svan H.	National School, Llanierres-		:	-	-	_	=		:		<u>:</u>	<u>:</u>	:	:	:	:	:	_	_
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Table showing Certificates held by Science Teachers-continued.

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Stone, William -	Ralliff Street, Wolverton	2nd	:	:	:	:	:	<u>:</u> :		<u>:</u> :	:	:	:	:	:	;
*Strachan, Richard Stroud, Robert Swaine, James *Tate, Ealph Taylor, Charles	11, Offord Road, Barnsbury, N. St. Mark's College, Chelsea. Bridge Street, Frome, Somerset Geological Society, Somerset House	:::::::	:::::	Srd 2nd	2nd 3rd	2nd 	2 nd	Srd Srd		ist 1st	3rd 2nd	d 2nd		::	: ::	:::::
Taylor, Samuel - Taylor, William Thackrab, Samuel - Thomas, James D Tindall, George	5, Havelock Terrace, Manchester Darfield School, Barnsley St. Mark's College. Chelsea S, Collefon Buildings, Excler Grove Street, Huddersfield		3rd 2nd	::ts:::	: : : :	: : : : :	:::::			:::::	::::: <u>s</u>	::::; ‡	: 33.5	:::::	:::::	:::::
Tomkins, Samuel Tribe, Alfred Trower, Richard Turner, George Turner, Samuel C.	Frampton Cotterill, Bristol. 12. Westbourne Grove, North & Over Street, Brighton National School, Queenshead, Halifax f. Maribro' Terrace, Victoria Road, W.		****	::::	:::::	grd 3rd	y W	Srd 2nd		3rd	::::::	::::::	1,2312	:::::	:::::	:::::
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For Her Majesty's Stationery Office.

[7253.—250.—9/64.]

SCIENCE AND ART DEPARTMENT OF THE COMMITTEE OF COUNCIL ON EDUCATION, South Kensington.

DIRECTORY,

(Revised in August 1865.)

12th EDITION.

WITH

REGULATIONS

FOR

ESTABLISHING AND CONDUCTING

SCIENCE SCHOOLS & CLASSES.

THE RULES IN THE PRESENT EDITION SUPERSEDE THOSE IN ALL FORMER EDITIONS,
BUT ARE ALWAYS SUBJECT TO REVISION.



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1865.

Price Sixpence.

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SCIENCE AND ART DEPARTMENT. COMMITTEE OF COUNCIL ON EDUCATION.

CROMWELL ROAD, SOUTH KENSINGTON.

Lord President, The Right Hon. the Earl GRANVILLE, K.G. Vice-President of the Committee of Council on Education, The Right Hon. H. A. BRUCE, M.P.

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Office hours to till 4.

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Assistant Secretary,—Norman MacLeod. Chief Clerk.—E. Stanley Poole.

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◆ The letters 8 and A refer to the Science and Art Certificates taken.

SUMMARY of the NATURE and AMOUNT of Assistance afforded by the Science and ART DEPARTMENT to the Industrial Classes in procuring Instruction in Science.

[Important Alterations made since the last edition of the Directory are printed in Italics.]

- I. A sum of money is voted annually by Parliament for scientific instruction in the United Kingdom.
- II. This sum is administered by the Science and Art Department.
- III. The head of the Education Department of which the Science and Art Department is a branch is the Lord President of the Council, assisted by a member of the Privy Council, who is called the Vice-President of the Committee on Education, and who acts under the direction of the Lord President, and for him in his absence. (Order in Council, 25th February 1856, Act 19 & 20 Vict. c. 116.)
- IV. The object of the grant is to promote instruction in Science especially among the industrial classes,* by affording a limited and partial aid or stimulus towards the founding and maintenance of Science schools and classes.†
- V. The payment of fees by the students result of fees by the solid and students. Students. Sufficient basis on which a self-supporting system can be established and supported. Though my Lords do not consider it necessary at present to lay down any rules making the payment of fees an absolute condition of the grants on account of Science

^{*} Direct payments are made to teachers only on behalf of adult artisans, or the children of artisans, or the children of persons who are not assessed to the income tax, or who do not possess an income of 100l. a year. (See § xiii.)

[†] The amount is liable to be decreased and eventually withdrawn. Payments to teachers therefore must not be looked upon as perpetual, or in any way conferring on the teacher a claim to any payments beyond those offered for each current year.

instruction, yet as the payments from the State must be expected to diminish, and as aid on account of those persons who do nothing for themselves cannot be justified, Committees of schools and classes, and Teachers, are strongly urged (should it at present not be the practice) at once to impose as high a scale of fees as they consider can be raised not only on middle class students but also on artisans.

VI. The following are the Sciences towards instruction in which aid is given:—

Subject 1, Practical Plane and Descriptive Geometry.

, 2, Mechanical and Machine Drawing.

- ,, 3, Building Construction or Naval Architecture.
 - 4, Elementary Mathematics.
 - , 5, Higher Mathematics.
 - 6, Theoretical Mechanics.

,, 7, Applied Mechanics.

- ,, 8, Acoustics, Light, and Heat.
 - , 9, Magnetism and Electricity.
 - , 10, Inorganic Chemistry.
- , 11, Organic Chemistry.

" 12, Geology.

, 13, Mineralogy.

" 14, Animal Physiology.

, 15, Zoology.

,, 16, Vegetable Physiology and Economic Botany.

17, Systematic Botany.

,, 18, Mining.

, 19, Metallurgy.

, 20, Navigation.

--- , 21, Nautical Astronomy.

,, 22, Steam.

23, Physical Geography.

VII. The assistance granted by the Science and Art Department is in the form of—

1. Payments on results to certificated teachers. (See § xv., xviii., xix., xx., and xxi.)

2. Grants towards the purchase of apparatus, &c.

(See § xxiii.)

3. Public examinations in which Queen's Medals, Honorary Certificates, and Prizes are awarded, held at all places complying with certain conditions. (See § xi., xii., xiii., xiv., xv., xvi., and xvii.) On the results of these examinations the payments are made to the teachers. (See § xv., xviii., xix., and xx.)

VIII. Examinations for certificates to Examinations teach any of the before-mentioned sciences Certificates. are held annually, commencing in the first week in November, at South Kensington. Examinations will also be held in Dublin and Edinburgh if five candidates register themselves for examination in Ireland and in Scotland. Any person whatever may attend this examination by sending in his or her name to the Secretary of the Science and Art Department, before the 15th October, stating the subject or subjects in which he wishes to be examined. ficates of three grades are given in each group and each subject. These certificates are only considered as simple records of the results of examination in the various sciences before mentioned, entitling the teacher to earn payments by successful teaching in the subjects for which he or she is certificated.*

IX. Suitable premises, with firing, light-mises. ing, &c., must be found and maintained at the cost of the locality where the school or class is held. If at any time the funds do not cover these requisite local expenses, it must be inferred that there is no such demand as the Government is justified in aiding, for instruction in the locality; and the assistance of the Department will be withdrawn.

X. A Local Committee of not less Local Committee. than five well known responsible persons must be formed in connexion with every Science

^{*} Such examination may be dispensed with in cases where the candidate has taken a degree, the examination for which satisfactorily meets the requirements of the case. Full particulars must be furnished by the applicant.

Class, who will carry out the instructions contained in Appendix. (See pages 14 and 16 to 20.)

Examination XI. The Science and Art Departof Classes ment holds, through the agency of each under Cer-Local Committee, in May of each year, tificated a public examination of all schools and classes in any locality throughout the United Kingdom which complies with the requisite conditions. (See § x., xiii., and xiv.) On the results of this examination the payments are made to certificated teachers. (See § xv., xviii., xix., and xx.) Application for it must be made before the end of March in each year, stating the number of persons and the subject or subjects in which they are to be The form of application, Science Form No. 119 (see page 20), will be sent on application to the Secretary, Science and Art Department.

In addition to the above, examinations in mathematics, navigation, nautical astronomy, steam, and physical geography are held for the benefit of seafaring men three times a year in all seaports where the Local Committees are formed and are willing to undertake them. These examinations take place in the beginnings of March, September, and December. The application for these examinations must be made on Science Form No. 119 before the 10th day of the

previous month.

Examination of other classes. A school or class taught by a teacher not holding a certificate, may, by applying to the Secretary of the Science and Art Department, be examined at the same time and in the same manner as the classes under certificated teachers; provided that a Local Committee be formed which complies with the requisite conditions. (See Appendix, pages 16 to 19, Science Form, No. 88 a.)

If the class be for artisans the pupils are eligible to receive Queen's Prizes and Queen's Medals under the same condition as the pupils of certificated teachers. Should it however be for the middle classes the pupils are not eligible for prizes and medals, but re-

ceive certificates of merit instead.

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XIII. If two or more classes in the same Places of town, or within a reasonable distance of one another, apply for the examination of the Science and Art Department, a general examination committee must be formed by the amalgamation of the several Committees to carry out the examinations at some common centre, such as the town hall or other public building. It is only when the classes consist of 100 or more candidates that such amalgamation of the committees will not be insisted on at present.

XIV. Any persons whatever, whether taught by the certificated teacher or not, students. may present themselves at the Local Committee's examination on registering their names in time for the Local Committee to comply with the instructions, and paying a registration fee of not more than 2s. 6d. each. Arrangements must therefore be made by the Local Committee, or the general examination committee, as the case may be, to enable other candidates, besides the students in the class for which the Committee act, to present themselves at this examination. The registration fee of 2s. 6d., which such candidates may be required to pay, is to reimburse the Committee for any extra expenses incurred by such attendance, and may at their option be remitted.

XV. The results of the May examina-Classification tion and of the quarterly examination of seamen are classified under the following heads:—(1) first class, (2) second class, (3) third class, (4) fourth class, (5) pass, and (6) failed. The names of the successful candidates, those under the first five heads, are published. The standard of attainment required may be raised from year to year. For the Pass it is only such as will justify the Examiner in reporting that the instruction has been sound, and that the students have benefited by it. Those who have attained a higher degree of proficiency are classed as 4th, 3rd, 2nd, or 1st class, according to their merit.

Queen's AVI. To the 1st, 2nd, and 3rd class are given Queen's prizes consisting of books or instruments chosen by the candidates from lists furnished for that purpose. These are unlimited in number, and are open to all candidates who come within either of the following categories, except as below, see a. and b. (1) Students in Science Classes under Certificated Teachers; (2) Registered Students in Artisan Classes taught by Non-certificated Teachers, or (3) bonâ fide artisans.

Other candidates, if successful, receive instead Certificates of merit recording their success.

The following are exceptions to the above rule.

- a. Science Certificated Teachers; and
- b. Students who have previously received the same, or a higher class prize, in the same subject.

The names of such candidates will simply be recorded in the published lists.

Queen's Medals. XVII. To the four best in each subject are awarded Queen's medals. These consist of one gold, one silver, and two bronze in each subject for competition throughout the United Kingdom. They are only awarded if there are a sufficient number of qualified candidates, and the gold medal will only be given in cases of high merit specially recommended by the examiner.

Only registered students of schools and classes under Local Committees (see § xi. and xii.) are eligible for medals. They cannot be taken by middle class students who are more than 17 years of age. Students who but for this restriction would have taken the medal, will receive an honorary certificate instead. Should a student take more than one gold, silver, or bronze medal, he will receive books instead of a second medal.

Payments to XVIII. Payments are made to the Teachers. certificated teacher in those subjects in which he is certificated on the following scale:—11.

for every student of the industrial classes who passes in each subject; 2l. for every one who obtains a 4th class; 3l., 4l., or 5l. for every one who obtains 3rd, 2nd, or 1st class; provided that such student has received 25* lessons at least from the certificated teacher in each subject since the last examination, each lesson being an attendance, at a meeting of the school, of at least three quarters of an hour duration on a separate evening.

The 25 lessons need not necessarily be all given in one year, but may extend over a longer period. 5*l*. is the maximum that can ever be claimed on account of the instruction of any one pupil in a subject, and this, only, subject to the reductions entailed by § xix. and xx. That is to say, for a pupil taking a 1st class for whom at a previous examination the teacher received the payment for a 3rd class, he can only claim 2*l*. If the same pupil had previously taken a 2nd class the teacher could only claim 1*l*. on his account, and so on.

XIX. If a student be successful at the examination in more than one subject, the teacher can only claim half of the above payments in respect of such further subject in which he is successful.

XX. Payments are only made on the foregoing scale when they amount to not more than 60l. When on this scale they would amount to more than 60l. the excess up to 40l. is diminished by one quarter, the excess above 40l. by one half. Thus payments which on the above scale would be 100l. and 150l. will be reduced to 90l. and 115l. respectively.†

† Thus, 100, that is 60+40, is reduced to $60+40-\frac{1}{4}$ of 40=60+30=90. 150, that is, 60+40+50 is reduced to

60+30+25=115.

^{*} It must be clearly understood that the number (25) of lessons which the teacher is required to give is the minimum fixed as a criterion that the pupil has received his instruction from the teacher, and is not meant in any way to specify that that amount of instruction is sufficient, or to guarantee the teacher's receiving payment, if that amount of instruction alone is given.

Form of Claim and the claim of a master for the payment. The claim of a master for the payments under these several heads is made on Science Form No. 51, which will be sent on application. The voucher must be signed by the secretary and two members of the committee of the science class or school; or by at least three of the committee. (See Appendix, page 22.)

School Register. XXII. A school register must be kept on a form which will be supplied on application. This must be made up from day to day, and will be examined and approved by the Inspector on his visit. It must be sent to the Department with the teacher's claim for payment, and no payment can be made unless it is properly kept.

Grants for Apparatus. XXIII. A grant towards the purchase of apparatus, diagrams, &c., of 50 per cent. on the cost of them, is made to science schools and classes in Mechanics' and similar institutions where the teacher is certificated, and to the extent of 51. to other poor schools and classes. A requisition must in these cases be made on Science Form, No. 49. (See page 27.)

Travelling Expenses of Teachers. XXIV. The travelling expenses (second-class railway fare, and 10s. per diem personal allowance) of a candidate in attending the November examination are paid if he be successful in taking a certificate or in improving the grade of one he has already taken, provided the candidate is bonâ fide engaged in tuition, or is preparing for tuition.

Instruction in an Elementary School.

XXV. All payments to certificated teachers on account of Science teaching are made by the Science and Art Department, and are only made in respect of a school in connexion with the Science and Art Department. They do not apply to any instruction in Science that may be given during the three

attendances of an Elementary School receiving aid from the Education Department, Whitehall.

XXVI. These grants are only made While the teacher is giving instruction School in a day or evening school or class Premises. for the industrial classes (adults or boys), approved by the Science and Art Department, and open at any time to the visit and inspection of its officers. The Managers of an Elementary School under the inspection of the Education Department can permit such part or parts of their premises to be used for Science teaching as shall not interfere in any way with the three attendances of the Elementary School.

XXVII. The certificated teachers of Pupil-teachers. elementary schools receiving aid from the Education Department, Whitehall, who have pupil-teachers to teach, cannot receive payments on account of Science teaching, even if holding a Science certificate.

XXVIII. But certificated teachers Masters without of elementary schools receiving aid from the Education Department who have not pupilteachers to teach have their time out of school-hours at their own disposal, so far as official regulations are concerned, and may if further certificated in Science give scientific instruction under the Science and Art Department.

N.B.—On the next page will be found a table of memoranda for the use of Secretaries and Members of Science Committees (Science Form, No. 170) which it is expected will be carefully attended to. This, as well as the other forms given in the Directory, can be had on application to the Secretary, Science and Art Department.

APPENDIX.

SCIENCE FORM, No. 170.

MEMORANDA FOR THE USE OF SECRETARIES AND MEMBERS OF SCIENCE COMMITTEES.

Dates.

Constantly - - -

Before 1st January

Before 31st March

Before 24th April -

On the 27th April

During the May examinations.

On the evening of examination.

After the May examinations.

Before 30th Novem- Formation of Committee, Form No. 88. tinuation of Committee, Form No. 168.

To visit the School and see that the Register is kept from day to day, and that everything is regular.

To carefully fill in and send to the Department. Form No. 120.

To send Form No. 119 applying for examination in

To see that Form No. 91 is hung up in the School-

If a parcel containing (1) the papers for the candidates to work upon, (2) copies of Form No. 91, one for each day's examination, and (3) envelopes in which to return the worked papers, should not have been received, or if there should be any mistake in the numbers sent for each subject as applied for, or in the covering letter, to communicate at once to the Department.

The examination papers for each evening will leave London by the night mail two evenings before, i.e., Thursday evening papers will leave on Tuesday evening, Friday's on Wednesday evening, etc. Should they not arrive accordingly, a telegram to be sent at once to the Department.

The candidates, being all seated at 6.50, to read out the rules on Form No. 91, then give out the papers to be worked on. Then at 6.55 to break the seal of the examination papers and distribute to the candidates. To adhere rigidly to the rules on Form No. 91. To sign Form No. 91. To seal up the papers in one of the envelopes provided and at once post them.

On receiving lists of the results to give one copy to each candidate whose name appears in it as being successful; to inform the others they have failed.

To return Form No. 161 filled up as soon as possible in strict accordance with the rules on Form No. 110. (Prize List). To return Form No. 123. To examine and certify Teacher's claims for payment, Form No. 51, and the School Register, which must be sent up at the same time. To return Form No. 108.

To keep a record of, and inform the Department of the number of individuals examined.

EXHIBITIONS, SCHOLARSHIPS, AND PRIZES, AT THE ROYAL SCHOOL OF MINES.

At the May 1866 examination two of the following Royal Exhibitions to the Royal School of Mines will be open for competition independent of the prizes, &c. offered by the Science and Art Department.

ROYAL EXHIBITIONS.

1. Eight Royal Exhibitions of the value of 501. each per annum entitling the holders to free admissions to all the lectures, and the Chemical and Metallurgical Laboratories at the Royal School of Mines, to be held from year to year for three years, on the condition that the holder attends the lectures and passes the examinations required for the associateship of the School.

All persons over 21 years of age, excepting artizans, and such as come within the category of persons paid upon under the Science Directory, will be excluded from competing for the Royal Exhibitions. Special cases, however, must be determined according to the spirit of the rules, and the object of the endowment.

The competition for the Royal Exhibitions will be determined by affixing the following values to the several results of the May examina-

mon,	ATE.	•—
•		To
		Ť.

To a 1st grade Queen	's Priz	e, in a n	y subjec	et -	• 9 m	arks
To a 2nd "	72		23	•	- 7	
To a 3rd ", To an honourable me			29	•	- 5	20
To a pass	IIVIOII		**	•	• •	99
	•	•	**	•	• 1	**
and in addition-						
For a gold medal	-	•	99	•	- 10	
For a silver medal	•	•	**	•	- 7	99
For a bronze medal	•	•	••	•	- 5	89

N.B.—Science Certificated Teachers may compete for the Royal Exhibitions. When coming up simply with this object, they should inform the Science and Art Department, so that their names may not appear in the published list with the students.

FREE ADMISSIONS.

2. Free admissions to the lectures at the School of Mines.

A free admission is granted to any person who takes a gold medal in the May examination.

There are, in addition, the following Scholarships attached to the

HIS ROYAL HIGHNESS THE DUKE OF CORNWALL'S SCHOLARSHIPS.

His Royal Highness the Prince of Wales, as Duke of Cornwall, has granted two scholarships of 301. each. One becomes vacant every year, and will be competed for by those students only who have passed the examinations of the first two years of the curriculum required for associates. It is held for two years by the successful competitor.

ROYAL SCHOLARSHIPS.

Two scholarships of 151. each are given to the students who shall stand highest on the list of those who have passed their examinations for the first year—and a scholarship of 251. to that pupil, not being the Duke of Cornwall's scholar, who passes the best examinations after the end of the second year. These scholarships will be granted to those students only who have obtained first-class places in the examinations of their year, or in those of at least two of the Professors in the case of such students as take the two first years in one.

For further particulars see prospectus of the "Royal School of Mines," to be had on application at the Museum in Jermyn Street.

SCIENCE FORM, No. 88.

LOCAL COMMITTEES FOR SCIENCE SCHOOLS AND CLASSES.

- 1. A Local Committee of not less than five well-known responsible persons must be formed in connexion with every Science class, in order to comply with the necessary requirements of the Science and Art Department, and to carry out various arrangements on its behalf necessary for testing the efficiency of the science instruction, on the proof of which alone the aid of the Department is given.
- 2. The gentlemen proposed to act on this Committee are to fill in the form on the next page, stating their willingness to carry out the necessary arrangements for examinations, &c., and giving the address and occupation of each member.
- 3. The relation of the Committee to the teacher of a Science school or class will vary much according to the varying circumstances of different localities. In some places where the demand for science instruction is great, and there is an energetic local teacher to take advantage of it, the chief duty of the Local Committee may be to give the teacher the necessary vouchers for obtaining his payments. While in other places, where those who take an interest in and wish to further science instruction may, with that object, subscribe to and establish scientific classes either in connexion with an existing institution or not, and may engage a teacher certificated in science to instruct the classes, the teacher must, to a great extent, be the paid officer of the Committee. With these local arrangements the Science and Art Department does not interfere, but leaves them to the locality to settle. The local circumstances will determine whether, as in the first case, the master receiving the whole of the fees for instruction should provide at his risk the room for instruction, with the necessary firing, lighting, &c., or what, as in the second case, should be the proportion of the fees deducted on this account by the Committee.
- 4. The Science and Art Department requires that the Local Committee shall
 - a. Be responsible for the safe custody of all apparatus towards the purchase of which the Department has paid 50 per cent.
 - b. That they shall provide a room or rooms of sufficient size to carry out the annual examination according to the detailed regulations under that head. This examination is of all persons who wish to present themselves, and not only of those taught by the certificated teacher; but those persons who are not taught by the certificated teacher must send in their names before the 1st March, and may be required to pay a registration fee of 2s. 6d. for the whole examination.
 - c. That a school register, showing the attendance, number of lessons, payment of fees, &c., on an approved form, be kept properly filled up, and sent to the Science and Art Department when required.
 - d. That they shall send in to the Secretary of the Science and Art Department the list of students to be examined, before the end of March, specifying the subjects in which they are to be examined. That they shall be responsible for conducting and superintending the examination: giving out the examination papers which will be

- sent for that purpose: seeing them worked fairly and certifying to the same, not less than three of the Committee being always present: and sending the worked papers, under seal, by the day's post to the Secretary of the Science and Art Department.
- e. That they shall certify, firstly, that those students on whose examination the teacher bases his claim to payments on results, are artizans or operatives, or their children, or can claim as such (see Science Form, No. 51); and, secondly, that they have received 25 lessons at least from the teacher in the year or since the last examination, on their passing at which payment was claimed on their account.
- 5. The Science school or class must be at all times open to the visit and inspection of the officers of the Science and Art Department as a condition to the grant of aid from it; if at any time it is found that the apparatus, &c., towards the purchase of which a grant has been made is not properly taken care of, or that a proper room with firing, lighting, &c., is not provided for the class, the aid of the Department will be with-

NOTE.—As it is to the Committee that the Department looks to carry out the great proportion of the duties of the school, as many as possible of the members of the Committee should attend on the inspector's visit.

FORM OF APPLICATION to act as a COMMITTEE for a Science School or Class. We the undersigned,

The Committee shall be composed entirely of well-known responsible persons of position who are quite independent of the school or class, and who have no such personal interest in it as can lay them open to the slightest suspicion of partiality; and of course no member should be connected with the Teacher, have any pupils for examination, or be a pupil himself.
 It is very desirable that as many persons as possible in recognised positions of public responsibility in the district, such as Magistrates, Municipal Authorities (Mayor, Aldermen, or Town Councillors), Head of Educational Establishments (Trustees of Grammar Schools, Managers of National Schools), Clergymen, &c., should be on the Committee.
 It is absolutely necessary that at least two such responsible persons should agree to act.

agree to act.

4. The Committee must consist of a Chairman, Secretary, and at least three other. Members.

The Committee must be a Magistrate, Mayor, Boroughreeve, Provost, or Alderman, or other public officer of recognized position, Trustee of Grammar School, or Clergyman of the Established Church in parochial employment.
 The Chairman of the Committee will inform My Lords as to the constitution of the Committee being in accordance with these requirements.
 The Secretary of the Committee of the Science School or Glass, as being the medium of communication, will carry on all correspondence with the Science and Art Department, and is held responsible for making out and sending all returns required, for the receipt and distribution of the examination papers, the transmission of the worked papers, &c., at the proper times according to the regulations; and in consequence of the necessary demands on his time and trouble My Lords have sanctioned, provisionally, the payment to him of the following fees:—It annually for furnishing the returns, &c. specified on Science Form, No. 170, connected with any Science school or class, and It in addition for each day's examination held by the Committee; the requirements in par. 1 apply equally to him.
 This form is to be filled in and returned to the Department annually before the 15th December, except in the case of new schools or classes, when it should be made as soon as they are formed.]

propose	to	act	28	the	Local	Commit	tee :	for	the	Science	Class	held	at

and taught by	
•	

ſ

We undertake for the year at least, and further till another Committee satisfactory to the Science and Art Department has been appointed.

- To be responsible for the safe custody of all the Apparatus, Diagrams, &c., towards the purchase of which the Department has in any way contributed.
- 2. That three or more of our number will be ready at the appointed time to be present at, and superintend, the examinations of the Science Class according to the instructions of the Science and Art Department, and give the teacher the necessary vouchers.
- 3. That a room or rooms shall be provided for the due carrying out of such examination, according to the rules of the Department, providing sufficient space for the examination, not only of all persons taught by the certificated teacher, but of all others who may wish to attend the examination.

(A fee of not more than 2s. 6d. may be charged on each applicant for examination who is not a student in the class, to reimburse the Committee in any extra expenses they may be put to in providing a room).

 That the School or Class shall be open at any time to the visit and inspection of the Officers of the Science and Art Department.

SIGNATURE.	Address,	Occupation, specially stating how fulfilling the conditions of "K." and "I." above.
Chairman.	· · · · · · · · · · · · · · · · · · ·	
Secretary.		

I certify that this Committee complies with the requirements of the rules 1, 2, 3, 4, and 5.

Chairman.

The Secretary,

Science and Art Department.

This form may be had on application to the Secretary, Science and Ast Department, South Kensington.

SCIENCE FORM, No. 168.

Where the same Committee proposes to act again it will not be necessary to resign the above, No. 88, but only to hold a meeting and fill up this form, No. 168, which may be had on application.

SCIENCE FORM, No. 88 a.

LOCAL COMMITTEES FOR SCIENCE SCHOOLS AND CLASSES NOT RECEIVING AID FROM BUT EXAMINED BY THE SCIENCE AND ART DEPARTMENT.

This Form is a modification of the previous, No. 88., and may be had on application to the Secretary, Science and Art Department, South Kensington.

SCIENCE FORM, No. 120.

SCIENCE CLASSES UNDER CERTIFICATED TEACHERS.

CLASSES IN (state subject).	Fees.	No. of Students.	Days on which they meet.	Hours of Meeting.	Period of the Year during which the Classes continue.
			-		
					·
	<u> </u>	1	<u> </u>	<u> </u>	

NAMES OF SECRETARY AND MEMBERS OF THE COMMITTEE.

(The undertaking on Science Form, No. 88, is for the year at least, and further till another Committee satisfactory to the Science and Art Department has been appointed. This Form, No. 88, must therefore be filled in and sent to the Department annually when the class recommences, except in those cases in which the whole of the Committee, wishing to continue, formally authorize the Chairman and Secretary to report to that effect. It will then only be necessary for now members to sign the form undertaking to erform the various duties.)



SCIENCE FORM, No. 119.

SCIENCE SCHOOL FOR EXAMINATION IN MAY. APPLICATION FROM

To be sent to the Secretary of the Science and Art Department before the end of March.

		Group I.		DIL.	Group	H,	Group II. Group III. Group IV. Group V.	IV.	Group	, ,	Group VI. Group VII. Group VIII.	Į,	Group	H.	Froup	HIL				
	96 HA	Geometrical Manager Drawing, P	Mechan- ioal Physics.	han- sics.	Experimental Physics.	tal ics.	Chemi	Chemistry.	Geology and Mineralogy.	logy.	יי בי	Animal hysiology and Zoology.	Vegetable Physiology, Economic, & Systems- tic Botany.		Mining and Metallurgy.	neg.	• •	Navig	Navigation.	_
	Sul	Subject.	Subj	Subject.	Subject.	ect.	Subject.	3ct.	Subject.	#	Subject.	ot.	Subject.	et.	Subject.	ti.		gng	Subject.	
	T	$\mathbf{r} \mid \mathbf{n} \mid \mathbf{n}$	T	г п.	т п.		L II.		1	H	1. IL I. II.	п	1. II.		I. II. II. III. IV. V.	ㅂ	1	ᄪ	T	<u>≯</u>
Number of students under in- struction during the year} Number intending to present themselves for examination Number intending to present themselves for examination not belonging to the class}																				

Total number of students * under instruction during the year

Name and address of the person to whom the examination papers are to be sent. Total number of students * intending to present themselves for examination.

Specify here the arrangements which have been made in accordance with § XIII. of the Science Directory to conduct the examination of N.B.—The address must be that to which the Examination papers are to be sent. any other classes in the town (if there be any) at the same centre.

* The total number of individual students only should be here given, so that if one student attends two or more classes he must only be counted as one.

FORM No. 868.

The following form, which may be had on application to the Secretary, Science and Art Department, is filled up in italics as an example of the manner in which it should be done.

An Account of Travelling and Personal Expenses disbursed and Charged by

Thomas Jones,

From the 2nd January 1860, to the 4th January 1860.

I hereby certify that the travelling expenses detailed below have been actually disbursed by me in travelling in the execution of my public duties, that the personal expenses are charged according to the regulations, and that the total sum of \pounds is due to me for the services stated.

In this column must be stated the service on account of which the journeys were performed, and the details of the expenses incurred.

Date upon which the

services were

Performed.

Thomas Jones.

TOTAL

AMOUNT.

[Name and title of officer to be specified.]

Teacher of Chemistry in _____ School of Manchester.

1950. 2nd January. 3rd January. 4th January. Norn.—Should at night, he is on Examined at	South Kes Raihvay fo (sna Class Omnibus fa South Kes Raihvay fa s days' perso I the successfu by to be allowe	examination in Ch sington on srd Jan re from Manche.) re to and from Eu sington re from London to mal allowance at 10 d candidate live in d ss. per diem besid	mary 1860. ster to Londo ston Square an Manchester 18. London or n	on - 1 4 0 od - 1 4 0 - 1 4 0	\$ 9 0 1 0 0 3 9 0 to get home
A Administration of	ia approvou,			•	
			Secretary.		
Received th	is	_day of		_18 ,	the sum of
	pounds	shillings	and	pene	e, in pay-
ment of the ab	ove amount.	-		•	
			1		
		•	1		
	-				



SCIENCE FORM No. 51.

SCIENCE AND ART DEPARTMENT OF THE COMMITTEE OF COUNCIL ON EDUCATION, SOUTH KENSINGTON.

Applie	cation from			_ Science Tea	scher in	· _
School or	r Institution	r at_			for payment.	
		Com	mittee of Man	agement of t	- his School, We de	hereby
certify :-						
	That Mr				erformed the vario	
đ					the School, du	ing the
40 -			gday			
					least 25 lessons	
					ich payment was ayment is claimed	
					ayment is claimed ans or operatives	
					uns or operatives ves by their own	
			hildren not ear			тиници
. "		1017 E	muren not ear	ning ineir own		
	-				Secret	ary. o mem-
•						ers of
	•			`	Cor	nmittee.
I here	by certify	that t	he following p	articulars are	correct.	
	•		0.2			acher.
						witer,
NTD ML					HE STUDENTS.*	
den	t's names of	st be	placed his sever	al successes (if	habetically. After the has more than o	ne); and
in t ded	he last colu uctions.	mn t	ne amount clain	ien on each and	cess after making th	e p roper
	ı	11		Position at		
	Christian	Age last Birthday.	Trade, or father's trade.	the late	Highest Position in same Subject	Pay-
urname.	Name in full.	8	(State which	Examination.	at any previous	ment claimed.
		T'A	is given).	Subject. Grade.	Examination.	
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&c.		1			1	
	•	1				I

^{*}Should the Teacher have instructed any Students who may fairly be considered to belong to the industrial classes, but whose wages are paid at longer intervals than a week, or who do not support themselves by their own manual labour, the claims on their account must be made by the Committee of the school on the form on page 3, when they will be considered on their merits.

24 On behalf of the Committee of the School, We, the undersigned, beg leave to recommend that the Teacher, Mr. be allowed to claim the allowances on the following students, whom we consider may fairly be taken as belonging to the industrial classes, as coming within one of the following categories, or being the children of such. a. Though paid at longer intervals than a week, still supporting himself by his own manual labour and not by profit on the labour of others, that is not employing apprentices, journeymen, &c. b. Though not supporting himself by manual labour, yet being of the same means and social level as those who do so (such as shopkeepers who have only petty stocks and employ no one but members of their own family), policemen, coast-guards, &c. c. Though not supporting himself by manual labour, yet such as it would be unreasonable to expect to pay the fee of middle class students, as some descriptions of clerks, shopmen, &c. We certify to the best of our belief-(1). That he has given them (25) lessons at least during the year, or since the last examination at which payment was claimed on their account, in each subject for which payment is claimed. (2). That they, or—in case they are not earning their own livelihood—their fathers are not assessed to the income tax. (3). That the following particulars on which the Teacher grounds his application are correct. Secretary. Two members of Committee. I hereby certify that the following particulars are correct. Teacher. NAMES OF PASSED STUDENTS CLAIMING AS INDUSTRIAL CLASSES. N.B.—The names of the students must be arranged alphabetically. After each student's name must be placed his several successes (if he has more than one); and in the last column the amount claimed on each success with the proper deductions.

*Under the names of students in category "c" a line must be drawn. Position at Trade, or Highest Position Christian Paythe late father's trade. in same subject Surname. Examination. ment Name in (State which at any previous Examination. full. claimed. is given). Subject. | Grade.

Science and Art Department.

(The following particulars will be filled up at South Kensington.)

Examined and found correct to the extent of

day of 186

Approved day of 186

&c.
The Secretary,

[SPECIMEN.]

Science Form, No. 51. South Kensington, July 1865.

SCIENCE AND ART DEPARTMENT OF THE COMMITTEE OF COUNCIL ON EDUCATION, SOUTH KENSINGTON.

Application from John Smith, Science Teacher in the Science School or Institution at Midhurst for payment.

On behalf of the Committee of Management of this School, We do hereby certify:—

(1.) That Mr. J. Smith has duly performed the various duties devolving upon him as a Science Teacher in the School, during the year ending 31st day of May 1865;

(2.) That he has given the following Students at least 25 lessons during the year, or since the last examination at which payment was claimed on their account, in each subject for which payment is claimed;

(3.) That the undermentioned students are artizans or operatives * in the receipt of weekly wages, supporting themselves by their own manual labour; or their children not earning their own livelihood.

Wm. Brown, Secretary.

John Jones, Two members of Committee.

I hereby certify that the following particulars are correct.

John Smith, Teacher.

Names of Passed Artizan or Operative Students.*

N.B.—The names of the students must be arranged alphabetically. After each student's name must be placed his several successes (if he has more than one); and in the last column the amount claimed on each success after making the proper deductiion.

Surname.	Christian Name in full.	Age last Birthday.	Trade, or father's trade. (State which is given).	Positio the l	ate tion in same ation. Subject at any previous		Payment claimed.
Adams, " Barder, Smith,	James, "" John Wm. Honry. William,	22	Carponter, " Butcher (f) Baker (f)	XI. XIV. XI. XII.	1st 2nd Pass 1st 4th 1st	Examination. 4th 2nd —	& s. 5 0 1 0 0 10 0 10 2 0 5 0

^{*} Should the Teacher have instructed any Students who may fairly be considered to belong to the industrial classes, but whose wages are paid at longer intervals than a week, or who do not support themselves by their own manual labour, the claims on their account must be made by the Committee of the school on the form on page 3, when they will be considered on their merits.

SCIENCE FORM, No. 108.

Application from	· · · · · · · · · · · · · · · · · · ·	_ Secretary of the Local
Committee for the Science Sci	hool or Class at_	
for payment of allowance for	duties connected	with the School, and for
superintending the examination		
		•
Sir.		
	nent according	to the regulations of the
Science " Directory, " for d		
		ntending the arrangements
for carrying out the examination	ns on	the following days
in May 186, I request that	the sum of 🗷 🔔	may
be paid to me, being the authori	ized fee.	
Dates of Examination. Date	es of Examination.	Dates of Examination
		
		
-	•	
	·	
•	I am, Sir,	
		obedient Servant.
The Secretary,		· ·
Science and Art Departme	ent.	
Soldison and 21.0 Soparem		
· ·		
CONDITIONS UNDER WHI		INSTRUMENTS BANKS
&c. MAY BE OBTAINED	D BY SCIENCE	Schools or Classes
(TAUGHT BY A TEAC)	HER CERTIFICA	TED IN SCIENCE),† IN
Public Schools, Mac	HANICS' INSTIT	rutions, &c.
1. The Lords of the Comm	ittee of Council	on Education, having had
under their consideration ser masters of Mechanics' and o	reral applications	s from the managers and
them of Apparatus and Illust	rations, recomme	ended by the Science and
Art Department for teaching	science, think it	necessary to adopt some
general principle which shall reference to such applications.	regulate the decis	sions of the Committee in

^{* £1} annually for furnishing the returns, &c. specified on Science Form No. 170, connected with any Science school or class, and £1 in addition for each day's examination held by the Committee to which he acts as Secretary.

† Apparatus not exceeding 10½ in value may be obtained by poor Schools and Mechanics Institutes, not taught by a certificated teacher, under the same conditions, that is, the Department will aid them to the extent of 5½.

Their Lordships have already fully recognized the great importance of practical science to all classes of the community, in all relations of life. They are, therefore, desirous that the Science and Art Department should assist, as far as possible, in promoting the distribution of diagrams and apparatus as the means of accomplishing this object; but as the indiscriminate gift of these aids for instruction to all applicants might lead to abuse, it is necessary to require some guarantee that they will be duly appreciated, which the mere request to have them does not imply.

The principle which governs the whole proceedings of the Department in all its branches is to afford partial aid, and to encourage, but not supersede public exertions in promoting education in science. They have, therefore, resolved that the Department shall have the power to assist schools and classes taught by a certificated teacher in Mechanics' and other institutions in purchasing diagrams and apparatus for teaching

science at a reduction of 50 per cent. on the net cost.

Lists of the scientific diagrams and apparatus prepared by the Department, according to conditions of the following Minute, may be obtained of the Secretary of the Science and Art Department, South Kensington, London, W. It should be distinctly understood that the aid of the Department in purchasing these articles at a reduced price, if above 101. in value, can be granted only to public schools and institutions when taught by a certificated teacher.

Minute of the 23rd March 1860,

"The Lords of the Committee of Council on Education desire to afford the greatest facilities to teachers of science and navigation schools in obtaining the best instruments, apparatus, &c., for giving instruction in science and navigation, towards the purchase of which the Science and Art Department is authorized to pay 50 per cent. of cost; and they consider that the fullest opportunities should be given to manufacturers in all parts of the Kingdom for supplying such apparatus, &c. At the same time it is necessary that the Science and Art Department should have some guarantee that the apparatus and instruments are of good quality, and moderate in price. My Lords have therefore laid down the following rules and conditions:—

- "1. Samples of all articles on the manufacturer's list are to be sent to the Educational Collection, South Kensington Museum, for exhibition, where they will be arranged separately, according to the science for which they are intended, so as to afford teachers and others facility in inspecting them and making a choice.
- "2. The manufacturer is to supply priced catalogues of such articles printed in demy 8vo., in order that the various catalogues may be bound up together and supplied when asked for.
- "3. The manufacturer is to guarantee that the articles exhibited are fair samples of those specified in the priced catalogue, and he must engage to take back any article supplied to schools which may be inferior to the standard."

Manufacturers willing to comply with these conditions are to make a statement to that effect, and to send lists of apparatus, instruments, books, &c. in the following sciences:—1. Practical plane and descriptive geometry, mechanical and machine drawing, and building construction; 2. Physics (mechanical and experimental); 3. Chemistry; 4. Geology and mineralogy; 5. Natural history (zoology and botany, vegetable and animal physiology); 6. Navigation and nautical astronomy, and physical

geography. If these lists and prices are such as can be approved of, the manufacturer will be informed, and as soon as possible on his fulfilling the conditions, his list will be inserted in the catalogue. The catalogue will undergo a revision at least once a year, when manufacturers may send any improved forms of apparatus, &c.

The selection of the manufacturer will lie wholly with the Committee of the school. On their demand being sanctioned, the manufacturer will receive instructions to supply the articles upon his receiving the 50 per cent, due from the school.

On obtaining a receipt from the Committee of the school (which is included in the form of the requisition) that the articles have been received, the remaining 50 per cent. will be paid quarterly to the manufacturer by the Department.

2. Payments, including charge for packing, must be made in advance to the agents on receipt of the invoice. The goods to be sent at the risk of the purchaser.

All communications to be addressed to the Secretary of the Science and Art Department, South Kensington, London, W.

By Order of the Committee of Council on Education.

N.B.—Apparatus grants will in future be rigorously confined to articles of a permanent and non-destructible nature; hence no aid will be afforded in the purchase of breakable articles, such as glass retorts, test tubes, &c., or, indeed, generally in the purchase of articles to be used by the student as distinguished from those of a permanent and illustrative character which are required by the teacher in giving instruction in science.

SCIENCE FORM, No. 49.

FORM of REQUISITION which may be had on application to the Secretary, Science and Art Department.

The following Requisition for Aid in purchasing apparatus, &c., after being filled up as required, is to be transmitted to "The Secretary of the Science and Art Department, South Kensington, London. W."

N.B.—It is to be understood that the Department has a lien on the apparatus, &c., furnished to public institutions to the amount of the public aid given in supplying them; they cannot therefore be sold.

them; they cannot therefore be sold.	
1. REQUISITION for AID in purchasing apparatus, &c. For the use of School or Institution (*)	No. 1 appli-
In the City or Town of (a)	filled in by
In the County of	Requisition-
Male Female	ist, with full par- ticulars.
Having (a) Pupils (Artizansor Operatives) of the Science Class.	
words that do not apply. and (a) Scholars or Members of Poor School or Mechanics Institute.	
Total.	
I request the aid of the Department in obtaining from M the apparatus, &c., named in the opposite page, and I undertake that the same shall be kept and used in the above-mentioned (*) school or institution for which they have been demanded.	
The address to which the parcel is to be sent is as follows:— To be forwarded to	
per———at	
To be forwarded toatSignature of Requisitionist. Dated thisday of186 .	
Dated thisay of	
2. Requisition sent to M Agent.	filled in by
this day of 186, and authority given for the supply of Articles to the extent of	the Depart- ment.
Net Sum	
of which &, together with the cost of packing, by the school or institution, previous to the goods being applied.	
Assistant Secretary.	
3. Invoice of articles sent to Requisitionist as under, this day	No. 8 to be filled in by
Articles (Retail Price) - & Deduct as above,—	agent on transmis- sion of the
Aid by Department	invoice.
Add, for packing	
Total to be paid by Requisitionist	
4 Amount 6 received from schools this	Nou 4 and 5
4. Amount 2——received from schools this——day ofagent.	to be filled in by agent.
5. Examples forwarded as directed above, together with Requisition, this day of	
6. Examples as per invoice received, and *Requisition returned to Agent, this day of Requisitionist.	filled in by
Requisitionist.	Requisition-

^{*} It is requested this paper may be returned to the Agent in an entire state after the examples have been received.

SCIENCE FORM, No. 91.

Rules for the Conduct of Science Examinations.

1. The following rules must be hung up in the examination room for the information of the candidates one week before the examination. They should all be carefully read by the members of the Committee. Those marked with an asterisk must be read aloud before the Committee. and the candidates on each night immediately before the examination

2. A room or rooms of such a size that, when seated, the candidates shall be at least five feet apart, from centre to centre, must be provided

for the examination.

*3. All Diagrams, &c. must be removed from the walls of the examination room.

4. Ink and blotting paper must be provided.

5. If one room is used three of the Committee must be present during the whole of the examination, if more than one room then two of the Committee per room,† who must carefully watch the whole examination and see that candidates use no unfair means either by assisting one another or using books or notes. The members of the Committee can, if they wish it, relieve one another, so long as the correct number are.

6. The examination papers will be forwarded, under cover, to the Secretary of the Committee so as to be received by him on the morning

of the day before that fixed for the examination.

*7. The candidates must be seated at their places at 6.50 p.m. After this time no candidate shall be admitted except under very exceptional circumstances, and that only by express permission of the Committee and if no person who has seen the examination paper has left the room. No candidate may on any account be admitted after 7.30 p.m.

*8. The examination papers must be opened in the examination room in the presence of the Committee, at 6.55 p.m. No examination paper

may be taken from the room till after 8 p.m.

*9. When the candidates are seated and the papers given out, the. Committee will see that the candidates commence by filling in their names. &c., where directed. All the worked papers must be collected at 10 p.m., initialed, put under cover, and sealed in the presence of the members of the Committee; and forwarded by the first post to the Secretary of the Science and Art Department.

* 10. Candidates must on no account bring anything with them into the examination room, t except pens and pencils. No scribbling paper, slates, or anything of that nature must be allowed. Arrangements must be made by which all books, note-books, &c., can be given up and left at the

door.

* 11. Candidates must not on any pretence whatever speak to one another after the papers have been given out. § If a candidate should require to ask a question, he will hold up his hand, when a member of the Committee will attend to him, but no question on the meaning of any portion of the examination paper must be asked or answered.

12. It may be of service to the Committee that the teacher of the

[†] When there are not more than three candidates it will not be necessary for more than two members of the Committee to be present at the examination.

‡ Except in the drawing examination, when drawing instruments are allowed.

§ It is absolutely necessary that nothing that can be passed from one candidate to another should be allowed. Rough work and calculations must be done on the supplied form, the back of each leaf of the form, i.e., pages 2, 4, 6, and 8, may be reserved for this purpose, the pen being drawn through to show that they are not for the examiner. But nothing must be torn off the form.



class should attend before the examination to assist in getting the candidates into their places, &c.; but from the peculiar character of the examination begins it is so very necessary that not the slightest opportunity for misconstruction should exist that it is evident that he should not be in the room after the examination papers are opened. Information of his having remained in the room after this will at once lead to the examination being declared null.*

*13. The examination papers being given out no candidate must be allowed to return after having once left the room.† On a candidate

leaving the room his papers must be taken up.

*14. At 10 p.m., precisely, all the candidates must cease working, and members of the Committee will collect their worked papers from them at their places. It will therefore be advisable to warn them ten minutes before the time. The papers will be initialed, by the Committee as. directed, as they are received from each candidate, as a guarantee that each has been worked by him whose name, &c., it bears. Should a candidate have completed his work before 10 p.m. he may, by permission of the Committee, go away at once, after his worked paper has been taken by a member of the Committee.

*15. Should a candidate break any of the foregoing rules, ask from or give information to another, or use unfair means of any description, he must be at once expelled the examination room, and his paper cancelled,

and the Committee will state on it the cause of his expulsion.

16. On these examinations depend large grants of public money. On their being fairly, honestly, and impartially carried out depends the continuance of the system. The Committees are intrusted with this duty. They will see, then, how necessary it is to be extremely careful in conducting them, and to insist on the foregoing rules being complied with to the letter. They are therefore required to sign and forward this form with each set of worked naners

hereby cert	ify that we wer	e present during the held in the	ne examination in
on the even papers were been strictly	complied with.	where sence, and that the fo	•
Signatures.			Time Present.
•	:		
.;* .:.			

retire within the room.

^{*}Should the teacher of the class wish to compete at this examination for the Royal Exhibitions of the Royal School of Mines, he must apply specially to the Committee for permission, so that they may arrange to have a table for him close to their own seats, and not with the other candidates.

† It will, therefore, be desirable to make some arrangement for the candidates to

SYLLABUS OF THE SUBJECTS IN WHICH CERTIFI-CATES AS TEACHERS OF SCIENCE ARE GIVEN BY THE DEPARTMENT OF SCIENCE AND ART.

THE following Syllabus has been prepared in order to afford candidates for certificates as teachers of Science, some guide to their reading; but it must be understood that the questions in the examination need not

necessarily be on the specific points enumerated.

The examination is by paper, but oral examination may be resorted to, and satisfactory evidence may be required of the teacher's power of giving information to a class. The groups are divided as shown, the examination in each subject being distinct, so that candidates may, if they desire it, take a certificate only in one subject of a group. Mention is made of text-books solely to afford a candidate some assistance in selection and a general idea of the scope of the examination, and not at all to confine his reading to those works or to assert that they are the best on the subjects they treat of.

Any certificate obtained at the examination may be raised, by reexamination, in the next or any following November to a higher grade.

A Course of Lectures as detailed below, on "Preparation for obtaining " Science Certificates and the Method of teaching a Science Class," has been delivered by direction of the Lords of the Committee of Council on Education. The lectures may be purchased, price 2d. each, at the book stall, South Kensington Museum, or on application by letter, enclosing postage stamps, to the Secretary, Department of Science and Art, South Kensington, London, W.

Group I. - Geometrical Drawing, &c. Prof. T. Bradley.

II. - Mechanical Physics - Rev. B. M. Cowie, M.A. Prof. Tyndall, F.R.S.Prof. Hofmann, F.R.S. III.- Experimental Physics ,,

IV. - Chemistry ,, V. - Geology - Prof. Ramsay, F.R.S.

Mineralogy, &c. - Prof.W. W. Smyth, M.A., F.R.S.

- Prof. Huxley, F.R.S. VI. - Zoology ,,

VII. Botany - Edwin Lankester, M.D., F.R.S. ,, Navigation and Nautical J. Riddle, F.R.A.S. Astronomy.

- Dr. G. Kinkel, F.R.G.S. Physical Geography

A Second Course has been delivered, of which the following have been published:-

Lecture I. - Vegetable Physio- Edwin Lankester, M.D., 3rd February. logy and Econo-F.R.S. mic Botany.

Mechanical Physics Rev. B. M. Cowie, B.D. 10th February. Lecture II. - W. W. Smyth, M.A., 24th February. Lecture IV. Mining F.R.S.

SYLLABUS.

A teacher will not receive any payments for Subjects II. or III. until he is certificated in I.

Subject I.—Practical Plane, and Descriptive Geometry.

Practical Geometry, plane and solid; required by architects, engineers, mechanists, shipbuilders, and others employed in arts of construction.

The candidate is expected to have acquired readiness in the use of the usual drawing instruments and materials, to be skilful in drawing lines and circles in Indian ink, plain or dotted, of different degrees of fineness; drawing parallel equi-distant lines, at least six inches long, and from five to twenty or thirty in an inch; drawing from ten to thirty lines, passing through one point and forming equal angles; dividing by trial lines and arcs into any number of equal parts. He should also be able to mend his drawing pens and other instruments, and to verify his rulers, &c.

Constructions in Plane Geometry.

 To draw lines through given points, in every position, either parallel, perpendicular to, or to form any proposed oblique angle, with given lines.

The use and construction of the protractor, and of the "scale of chords" for these purposes, should be understood, and the deduction of certain angles from the direct division of the circle.

To draw circles or arcs, through given points, to touch given lines or circles, and, conversely, lines to touch circles.

Required in drawing framework for machinery, architectural designs, ornamentation, &c.

3. The principles of drawing symmetrical forms by means of co-ordinates to the axis of symmetry.

This is the basis of all drawing, of all objects of construction, which are universally symmetrical, not only in architecture, civil and naval, but in machinery and engineering works of all kinds.

 Constructions of figures similar to given rectilinear or mixtilinear figures.

Here the construction and use of "scales" plain and comparative, should be thoroughly understood and explained, and the principles of the diagonal and the vernier subdivision. Also the mode of reducing or enlarging drawings by means of similar rectangles, termed squaring a drawing. The use of the sector and of proportional compasses, and of the pentagraph and eidograph, in facilitating copying should be known.

- To construct rectilinear figures similar to given ones, but with a proposed area.
- 6. To determine by construction numerical quantities such as \sqrt{m} ; $\sqrt{\frac{a^2+b^2}{m}}$; $\sqrt{a^2+b^2}$, &c.

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7. To construct a triangle, any three parts being given.

Used in levelling, surveying, and the determination of heights and distances. Great accuracy, neatness, and distinctness of construction, will be insisted on: Geometrical drawing is valueless unless it possesses these requisites. A few illustrations of constructions on the ground, by means of a "chain," pins and cords, necessary in surveying, and "setting out" buildings and earthworks, may be added to the course, as well as the solution of a few elementary problems by means of the compasses alone.

8. The delineation of a few of the curve lines required in the arts, such as the ellipse, cycloidal curves, the involute and sinusoid, with the graphical method of determining their tangents and normals.

Required in designing elliptic arches, oblique bridges, teeth of wheels, cam-work, screws, &c.

- Practice in tinting and shading with Indian ink, so as to express curved surfaces and shadows.
- For the preceding part of the course, a fair knowledge of the first six books of Euclid is strongly enjoined, some acquaintance also with trigonometry will be of service, as without such previous knowledge, the learner is simply copying what is set before him, and cannot attain the highest skill in drawing.

Constructions in Solid Geometry.

(Descriptive Geometry.)

Preceded by explanations of the term projection, and of the necessity for it, in order to express graphically, on a surface, solids of any kind; the distinction between orthographic and perspective projections; their uses, and general principles which are the foundation of their practical application.

Orthographic Projection.

- Why the projections, of any solid consisting of a combination of geometric forms, on two or three co-ordinate planes are necessary to show the form and dimensions of that solid.
- Meaning of the terms plan, elevation, profile, section. The principle of the representation of surfaces by the projections of their generators, or of equi-distant horizontal sections termed contours. The direction and inclination of an indefinitely extended plane given by its contours, or by its traces on any two co-ordinate planes.
- These principles should be quite familiar to the candidate, and will be tested by making him draw plans, elevations, and sections of simple solids, as prisms, pyramids, cones, spheres, cylinders, and of symmetrical solids formed by their combinations.
- A few of the problems relating to points, lines, planes, and curved surfaces, will be required, as—
- To draw lines and planes parallel or perpendicular to each other, to contain given points or lines, and the limits of the possibility of solution of any problem should always be understood.
- The preceding constructions combined and applied to determine by their projections the simple solids before mentioned, when they are not symmetrically situated with respect to the supposed planes of projection.

3. Applications to the intersections of surfaces, and of the development of such as admit of it.

This may be considered the most important part of descriptive geometry to the artizan, as it is required in all arts of construction. The mason, carpenter, and shipwright, workers in tin-plate, boiler makers, &c., would all be benefited by a knowledge of it.

This application has been termed Stereotomy, and better and more "

significantly in French, "Coupe de pierres."

Much practical knowledge of the subject, arising from their pursuits, is possessed by workmen, while the want of a scientific knowledge of it compels architects, engineers, and their drawing clerks to leave to the workmen the execution of their conceptions which they cannot themselves design.

 The solution by construction of the spherical triangle from any three given parts, is mentioned.

As important to masters, mates, and others engaged in any kind of astronomical calculations.

Isometric Projection.

Is usefully employed in the representation of works chiefly of a rectangular form, such as timber framing, canal-locks, and many parts of machinery; its use is much increasing: it is readily understood, and can be practised by anyone who has gone through the first two articles of this section.

Perspective Projection.

May be taken up, but will not be insisted on as it is rarely used except by architects to represent buildings (not yet executed), as they would appear to the eye at any spot from which they could be viewed, and the power of applying it for this purpose is possessed by many who know little of the really easier subject of descriptive geometry; but as its application by the architect must be subordinated to artistic taste, this consideration excludes it, in some measure, from a purely geometrical course.

No one, however, can be considered a scientific draughtsman unless he can apply perspective projection to the projection of shadows, the projections of the sphere, the constructions of maps and dials, and

some other uses.

For the second division of this course, in addition to what was before indicated, a competent knowledge of the theorems relating to the line and plane (Euclid, Book XI.), and an acquaintance with the leading properties of the conic sections, the geometry of the sphere, and some spherical trigonometry is important, it cannot be too urgently recommended to all persons wishing to master this course, to study such works as "Geometry, Plane, Solid, and Spherical" of the Eurary of Useful Knowledge, and Mr. Bell's, in Chambers' Educational Course.

Geometry, Plain, Solid, and Spherical (Library of Useful Knowledge) is especially recommended as a work to be studied on Theoretical Geometry.

Text-Books for Practical Plane Geometry.—Bradley's Geometrical Drawing: Burchett's Practical Geometry: Practical Geometry, Linear Per-

spective and Projection (Library of Useful Knowledge).

For Descriptive Geometry.—Bradley's Geometrical Drawing; Hall's Elements of Descriptive Geometry for Students in Engineering.—Heather's Descriptive Geometry. Also the following French Works, which are mentioned in consequence of the great deficiency of English Works on Geometrical Drawing.—Elémens de Géométrie Descriptive, par S. F. Lacroix; Traité de Géométrie Descriptive, par Levebure de Fourcy;

Nouveau Cours raisonné de Dessin Industriel, par Armengaud, aîné, et Armengaud, jeune, et Amouroux; Bardin's Works on Descriptive Geometry.

Subject II.—Mechanical and Machine Drawing.

- The candidates in Subjects II. and III. will, some time before the examination, have specifications of subjects given to them, of which they will be required to prepare drawings before the examination. These drawings must be bond fide their own. The candidates may be examined on them, and if the results be satisfactory, they will count towards their certificates, but they will only be taken into consideration when it is clearly seen from the regular examination that the candidate is qualified for a certificate.
- The application of the foregoing Subject I. to the drawing of machinery, in which great accuracy and neatness of drawing will be insisted on.
- The candidate will be required to take measurements with calipers, &c., and to make drawings, elevations, and sections of a simple machine, or of parts of one, set before him. Also to draw a portion of a machine from written dimensions and description. He will be required to have sufficient knowledge of the principles of machinery, gearing, &c., to be able to make working drawings of a machine or portions of a machine from a rough sketch, applying the power to the greatest advantage, and obtaining such power or changes of motion as are required. In fine, such knowledge and readiness as would be required of a good draughtsman in an engineer's office.

Subject III.—Building Construction, or Naval Architecture.

(See previous Subject.)

- The candidate will be required to possess sufficient knowledge of construction—(1) to apply the various materials used in building to their greatest advantage; (2) to be able to make detail and working drawings showing a knowledge of the methods of construction and the framing of ordinary roofs, bridges, &c., whether of wood, iron, or masonry; (3) to frame estimates and take out quantities.
- Neatness, accuracy, and facility in drawing will be insisted on, and the general requirements in this Subject will be such as would be possessed by a good draughtsman in an architect or builder's office, with a slight scientific knowledge for the proper application of the materials he is required to work with.
- N.B.—Naval Architecture may be taken instead of Building Construction; the same description of attainments will be required.

Subject IV.—Elementary Mathematics.

1. Arithmetic generally.

Geometry.—The properties of lines, triangles, rectilinear figures, the
circle; properties of similar figures; proportion of figures; inscribed
and circumscribed polygons. The questions will have reference to
Euclid's elements; but a sound knowledge of Geometry obtained
from any source will be accepted.

3. Algebra.—Definitions. Addition. Subtraction. Multiplication. Division. Greatest common measure. Least common multiple. Theory of indices (integral). Involution. Evolution. Simple

equations, and problems producing them. Fractions. Quadratic equations, and problems producing them. Ratio. Variation. Arithmetical, geometrical, and harmonical Progressions. Permutations, and Combinations. Binomial theorem for a positive

integral index.

4. Plane Trigonometry.—Definitions. Conversion of degrees and their subdivisions into grades, and their subdivisions, and vice versa. Angular and circular measures of degrees and their relation. The goniometric functions of angles and the conversion of one into another. The arithmetical values of the goniometric functions of 90°, 45°, 60°, 30°, 180°, 120°, 150°, &c. The meaning of contrariety of signs in trigonometry. Tracing of the goniometric functions in magnitude and algebraic sign through the four quadrants and when an angle is indefinitely increased.

Formulæ for multiplication and division of angles, viz., sine, cosine, tangent, &c., of $(A \pm B)$, 2A, 3A, $\frac{A}{2}$, and $\frac{A}{3}$. Also of A and B in

terms of
$$\frac{A+B}{2}$$
 and $\frac{A-B}{2}$.

Logarithms.—Definition. Multiplication, Division, Involution and Evolution by logs. The use of logarithmic tables. Tables of proportional parts for numbers and angles. Modulus. of logarithmic tables, and of tables of logarithmic sines, cosines, &c.

Triangles.—Formulæ for cosine of an angle of a triangle in terms of its sides. The relation between sines of angles and the opposite sides; sine, cosine, tangent, &c., of half an angle of a triangle in terms of sides, and of the sine of an angle. Area of a triangle. Solution of triangles. Diameters of circles inscribed in and circumscribed about a given triangle. Areas of regular polygons inscribed in and circumscribed about a given circle. Area of a circle. Description and use of vernier and theodolite and sextant (generally). Heights and distances of inaccessible objects.

For students to pass, a competent knowledge of the following alone

will be required:—
(1.) Geometry. The first book of Euclid.
(2.) Algebra, to simple equations and problems (inclusive).

(3.) Plane trigonometry. The more elementary portions, including use of logarithms.

To obtain an honourable mention :-

(1.) Geometry. The first three books of Euclid. (2.) Algebra, to quadratic equations.

(3.) Plane trigonometry as far as solution of triangles, inclusive.

(4.) Splanical stringeroundry we for

And for third, second, and first class Queen's prizes the remaining portion of the above subjects.

Subject V.-Higher Mathematics.

1. Algebra.—Surds. Theory of indices (fractional and negative). Binomial theorem generally. Multinomial theorem. Exponential theorem. Indeterminate equations and problems. Indeterminate coefficients. Reversion of series. Properties of numbers.

2. Plane Trigonometry.—De Moivre's theorem and the expansion of

sine, cosine, and tangent in terms of the angle.

Spherical Trigonometry.—Definitions and fundamental propositions. Polar or supplemental triangle and its properties. Area of a spherical triangle. Spherical excess.

Fundamental formulæ expressing the relations of the sides and angles of a spherical triangle.

Napier's analogies.

Solution of right-angled spherical triangles and of oblique angled

triangles.

Mensuration.—Trapeziums. Regular plane rectilinear figures. Irregular plane curvilinear figures (Simpson's or Stirling's Rules). Volumes and surfaces of Parallelopipeds, Pyramids, Cylinders, Cones, and Spheres.

Differential and Integral Calculus.—Definitions. Differential of elementary functions, including circular and logarithmic functions. Vanishing fractions. Maxima and minima of one independent variable. Tangents and normals of curves. Differential coefficients of Areas, Arcs, Volumes and surfaces of solids of revolution.

Integration of elementary functions. Integration by parts. Rational fractions. Integration between limits. Areas and lengths of simple curves. Volumes and surfaces of solids of revolution.

Subject VI.—Mechanics as a Science, or Theoretical Mechanics.

Statics. Composition and resolution of forces. Forces acting on a point—on a rigid body. Parallel forces. Centre of gravity. Theory of moments or couples. Principle of virtual velocities. The mechanical powers. Friction. Equilibrium of roofs and arches.

Dynamics. Laws of motion. Uniformly accelerated motion. Motion by gravity Variable forces. Projectiles. Centrifugal force. Motion on inclined planes—on curves. Pendulums. Motion of rigid bodies, free or constrained. Moment of Inertia. Centre of oscillation—of percussion. Motion of flexible bodies, such as a musical string.

Hydrostatics, Hydrodynamics, and Pneumatics. Mechanical properties of liquids. Law of pressure. Centre of pressure. Laws of floating bodies. Capillary attraction. Laws of fluid motion, through open

channels, closed pipes, or orifices.

Mechanical properties of elastic fluids. Theory of barometers. Connexion between pressure, temperature, and volume. Specific heat. Weight of atmosphere. Use of barometer in calculating heights.

In this subject the candidate will have to show a mathematical knowledge of the laws of Mechanics, and must be able to prove from

first principles the principal theorems.

The books recommended for study are—Whewell's Elements of Mechanics, or Snowball's; Moseley's Engineering Architecture; Natural Philosophy, by Dr. Golding Bird and Mr. Brooke; Goodwin's Elementary Course.

Subject VII.—Mechanics as an Art, or Applied Mechanics.

General principles of mechanism. Elementary combinations. When the connexion is by rolling contact, sliding contact, wrapping connectors or linkwork, with constant or varying velocity ratio, and constant or

varying directional relation.

Machines of ordinary occurrence must be thoroughly understood and particular parts to be described and drawn: such as cranes; lathes; drills: planing, punching, boring, shaping, and slotting machines. Spinning and weaving machinery. Mode of calculating power of machinery. Dynamometers, indicators, &c.

Materials. The general properties of materials. Elasticity. Weight. Specific weight. Mechanical work. Work done by pressure, by

impact, by expansion of elastic gases and steam, by animal muscular effort.

Resistance to expansion, to compression, to rupture. Friction of solids. Its importance in construction. Resistance of fluids to bodies moving within them. Adaptation of form and material for maximum resistance. Beams of greatest strength. Construction of roofs, arches, stone and timber bridges, suspension bridges, and tubular girders.

Hydrostatics, Hydrodynamics, and Pneumatics. Pressure on floodgates; locks; water-wheels; turbines; water-pressure engines; breakwaters. Hydrometers. The syphon. Hydraulic ram. Pumps. Diving bell. Condenser. Windmills. Steam-engines, stationary marine, locomotive. The steam hammer. Water supply to towns.

Theory of tides, in the open sea, and in rivers.

In this subject the candidate will be expected to show how the principles are applied in actual practice: he will be expected to show by clear well-drawn sketches, his acquaintance with parts of machines.

The candidate will have tools and models put before him, with some of which he must show he is familiar, and that he can explain their use

and construction.

Books recommended,—Willis's Mechanism; Baker's Elements of Mechanism; the books in Weale's Series which treat on the subjects specified. Twisden's Practical Mechanics; Goodeve's Elements of Mechanism.

Subject VIII.—Acoustics, Light, and Heat.

Acoustics.

The candidate ought to know the manner in which sound originates, and is propagated; its velocity in different media, and how its velocity

through air is affected by density and temperature.

He ought to know the origin of musical sounds; of pitch; of harmony and discord; to commit to memory the rates of vibration of the several notes of the gamut; to be able to make sonorous vibrations visible by means of glass plates and membranes; to calculate the length of sonorous waves, and to determine practically the number of vibrations due to any particular note. He ought therefore to understand the construction and use of the Syren.

He ought to be able to describe and illustrate the condition of a vibrating string, or column of air at its nodal points and ventral segments and

to explain echos and resonance.

Light.

The candidate ought to know how its velocity was first determined from

observations upon Jupiter's satellites.

He ought to be able to devise a simple means of exhibiting both the reflection and refraction of light; to be able to state the laws of both; to explain what is meant by total reflection; and to apply it to the explanation of the Mirage of the Desert, the Phantom Ship, and other similar phenomena.

He ought to be able to explain why the image in a plane mirror must appear as far behind the mirror as the object is in front of it; why a stick appears bent when dipped obliquely into water; and why the bottom of a river or lake, or of a basin which holds water, appears to

be nearer to the surface than it really is.

He ought to be able to determine the positions of the foci of spherical mirrors, both concave and convex; to describe the characters of their images, whether erect or inverted; magnified or reduced; and to do the same for convergent and divergent lenses.

He ought to know the construction of the human eye; the conditions of distinct vision, the use of spectacles; and to be able to describe a simple form of the reflecting and refracting telescope and of the microscope.

He ought to know the constitution of light; to be able to describe the spectrum produced by refraction with a prism; to explain the origin

of colours, and to give a clear explanation of the rainbow.

Heat.

The candidate ought to be able to describe the construction and graduation of an ordinary mercurial thermometer; to understand the scales of Fahrenheit, Celsius, and Reaumur.

He ought to have clear ideas of conduction and radiation; to be able to devise some simple means whereby the conductive and radiative powers of different bodies may be determined; to explain fully the formation of dew, and to state the conditions favourable to its production.

He ought to know the effect of heat upon the volumes of bodies; to know what is meant by the coefficient of expansion, and how it may be determined; to give illustrations of the enormous power of heat in producing expansion; to state exceptional cases; to know the manner in which heat is propagated through liquids and gases, as distinguished from ordinary conduction; and to be able to combine two metals possessing different coefficients of expansion, so as to form a compensating pendulum.

He ought to know the meaning of latent heat and of specific heat, and to illustrate both by reference to ice, water, and steam; he ought to be able to show the influence of the high specific heat of water upon

an island climate.

He ought to know the strict physical meaning of ebullition; and the influence of pressure upon the boiling points of liquids; he ought to have a general knowledge of the origin of winds and clouds, and to be able to explain the fact that the rain-fall upon the south-west side of a mountain chain in England and Ireland is much more copious than on the north-east side.

Subject IX.-Magnetism and Electricity.

Magnetism.

The candidate ought to know the action of one loadstone upon another which is freely suspended, or set afloat upon a liquid; he must have a perfectly clear notion of magnetic polarity, and of the action of magnetic poles upon each other.

He must know the difference between the action of magnetised and unmagnetised steel upon a magnetic needle; also the difference between soft iron and hard steel, with regard to their acceptance and

retention of the magnetic condition; (coercive force).

He must be able clearly to state the condition of a mass of soft iron when under the influence of a magnet, and in virtue of which condi-

tion the iron is attracted; (magnetic induction).

He must be able to describe the action of the earth upon a magnetic needle; must know the meaning of declination, inclination or dip, and of secular and diurnal variation; the action of the earth upon a bar of soft iron according as it is held in the direction of the dip or at right angles to this direction; finally, the effect of percussion in rendering the condition assumed by the bar of soft iron a permanent one.

He ought to be able to compare accurately the strength of one magnet with that of another, and to state how the relative intensity of the earth's magnetism at two points of its surface may be ascertained.

Frictional Electricity.

The candidate ought to know various simple ways of exciting electricity to be clearly informed as to the duplex character of the force; to know the condition of the rubber as well as that of the body rubbed; and to be conversant with various forms of electroscopes and electrometers.

He ought to know the foundation of the terms vitreous and resinous, positive and negative; to be able to illustrate the action of two electrified bodies upon each other; and to tell at once whether a body is

positively or negatively charged.

He ought to have a clear knowledge of electric conduction, insulation, and induction; and be able to explain the state of a neutral conductor when acted upon by an electrified body; he ought to be able to prove, experimentally, that though we cannot by breaking a magnet obtain two halves each with a single pole, we can by breaking an electrified body obtain two halves each charged with a single electricity.

He ought to be able to explain the influence of points and flames when attached to an electrified conductor; and to describe the action of

lightning conductors.

He ought to be able to describe the electric machine, and the electrophorus; and to explain the action of the condenser and of the Leyden jar.

He ought to be able to state the principal effects of the electric discharge; to state the atmospheric conditions necessary to the production of a thunderstorm; and to give a clear account of the so-called return stroke.

Voltaic Electricity.

The candidate ought to be able to state precisely how voltaic electricity may be generated; to describe Volta's pile, and his crown of cups;

and also the batteries of Daniell, Grove, and Bunsen.

He must have a clear conception of what is meant by the direction of an electric current; and be able to illustrate in the fullest manner the action of a current upon a freely suspended magnetic needle. Given the direction of the current, he must be able to state how the needle moves; given the movement of the needle, he must be able to infer from it the direction of the current.

He must be able to describe fully the action of a current upon soft iron; and to infer from the direction of the current the nature and position

of the magnetic poles, which it excites.

He must be well acquainted with the chemical reactions which take place both in the batteries, mentioned above, and also in other liquids

through which the current may be sent.

He must be able to measure the strength of an electric current, and he is strongly recommended to master thoroughly the law of Ohm, regarding the mutual relations of electromotive force, resistance, and strength of current.

He ought to be acquainted with the so-called polarisation of metallic plates between which a current passes through a liquid, and to show

how this is avoided in Grove's battery.

He ought to be able to give a clear description of some one form of the

electric telegraph.

He ought to be acquainted with the physiological effects, and with those of light and heat produced by the voltaic current; and to show the dependence of the heat on the strength of the current, and on the resistance which it encounters.

It would also be well to master as much of the phenomena of induced currents as would enable the candidate to explain the action of the

galvanizing apparatus used by medical men.

Norg.—This candidate will perceive that this list is long because the objects to which he is to devote his attention are separately specified. Definition is thus given to his studies and their precise scope marked out for him. He is recommended to repeat with his own hands, as far as it is in his power to do so, the experiments which he finds described in good handbooks of Natural Philosophy; this will give a certainty to his knowledge and an interest to his pursuits which mere reading can never confer. The first requisite demanded of him on his examination will be that, however small his knowledge, it shall be well digested and sound.

'Text-Books:-Lardner's Handbook of Natural Philosophy; Natural Philosophy, by Dr. Golding Bird and Mr. Brooke.

Subject M.-Inorganic Chemistry.

The general principles of chemical philosophy. Laws of combination. Combining weights and chemical equivalents. Combining volumes. Chemical symbols and their use in the explanation of chemical The atomic theory. changes.

The non-metallic elements: Oxygen. Combustion.

. Hydrogen. Water. Chemical composition and properties. Adaptation for domestic purposes. Hardness, permanent and temporary.

Nitrous oxide, nitric oxide. Nitric acid. Nitrification. Nitrogen.

Ammonia.

Carbon. Process of carbonization. Carbonic oxide. Carbonic acid. Marsh gas. Olefiant gas. Manufacture of coal gas.

Sulphur. Sulphurous acid, sulphuric acid. Sulphuretted hydrogen.

Bisulphide of carbon.

Chlorine. Hypochlorous acid. Bleaching agents and theory of bleach-Chloric acid and perchloric acid. Chloride of nitrogen. Chlorides of carbon.

Bromine. Bromic acid and hydrobromic acid.

Iodine. Iodic acid, periodic acid, and hydriodic acid.

Fluorine. Hydrofluoric acid.

Phosphorus. Hypophosphorous acid, phosphorous acid. The several modifications of phosphoric acid: ordinary phosphoric, pyrophosphoric, and metaphosphoric acids. Theory of polybasic acids. Phosphoric acids. phoretted hydrogen. Chlorides of phosphorus. Manufacture of matches.

Boron and boracic acid. Silicium and silicic acid.

The metals: Potassium. Manufacture of nitre. Manufacture of gunpowder. Theory of the action of gunpowder. Sodium. Manufacture of carbonate of soda.

Calcium. Mortars. Barium. Strontium.

- Magnesium, Aluminium. Manufacture of glass and porcelain.

Manganese. Iron. Composition and properties of cast iron, wrought iron, and steel.

Cobalt. Nickel. Chromium. Zinc. Cadmium. Copper. Lead. Manufacture of white lead.

Bismuth. Mercury. Tin. Arsenic. Course of analysis in cases of poisoning.

Antimony. Silver. Gold, and platinum. Their principal compounds with the non-metallic elements.

Outline of qualitative analysis. Reactions of the principal mineral acids and bases. Course pursued in the application of these reactions to the analysis of a mixture of several acids and bases.

The following is the list of Apparatus and Re-agents with which Candidates make their analysis at the examination :--

APPARATUS.

Test tubes and stand. Metal filter stand. Wash bottle containing distilled water. Spirit lamp. Black blowpipe. Charcoal for blowpipe experiments.

Iron spoon. Tongs. Pestle and mortar. Porcelain dishes. Watch glasses. Porcelain crucible. Triangles. Test tube cleaner.

Platinum wire and foil. Funnels. Cut filters. Sulphuretted hydrogen apparatus. Platinum crucible. Herapath's blowpipe. Stirring rods.

RE-AGENTS.

Sulphuric acid. Hydrochloric acid. Nitric acid. Hydrosulphuric acid. Potassa. Ammonia. Chloride of ammonium. ·Sulphide of ammonium. Carbonate of ammonium.

In the liquid state. Phosphate of sodium. Chloride of barium. Chloride of calcium. Lime water. Sulphate of calcium. Sulphate of potassium. Sulphate of magnesium. Chromate of potassium. Oxalic acid. Tartaric acid. In the solid state.

Acetic acid. Hydrofluosilicic acid. Oxalate of ammonium. Acetate of lead. Sesquichloride of iron. Ferrocyanide of potassium. Chloride of platinum. Nitrate of silver.

Carbonate of sodium. Nitrate of potassium. Cyanide of potassium.

Borax. Lime. Sulphate of iron.

Blue and red litmus paper.

Subject XI .- Organic Chemistry.

Ultimate analysis of organic bodies. Calculation of an empirical formula. Methods of controlling an empirical formula. Determination of the equivalents of organic acids and bases, examination of products of decomposition, determination of the vapour-density of volatile hodies. Law of substitution.

The chemical history of the Cyanogen group. Cyanogen. Hydrocyanic acid. Cyanic acid and urea. Fulminates. Cyanuric acid. Sulpho-

cyanic acid. Chlorides of cyanogen.

Amylaceous and saccharine substances. Fermentation. Alcohol, and its homologues. Ethers, simple and mixed. Oxidation of alcohol, Aldehyde and acetic acid, and their homologues. Anhydrides, simple and mixed. Compound ethers. Diatomic alcohols and their acids. Glycol and oxalic acid. Triatomic alcohols. Glycerine. Fatty and oily bodies.

'Ammonia and its derivatives. Amides and amines: their classification.

Examples of natural alkaloids.

Principal colouring matters. Indigo and its derivatives. Examples of products formed by destructive distillation.

The chief constituents of the vegetable and animal organism, fibrin,

albumen, casein, &c.

The chemical principles of agriculture.

The chemical principles of the process of nutrition and respiration in

the animal organism.

Text-books. — Graham's Elements of Chemistry, Miller's System of Chemistry, Fownes' Manual of Chemistry, Gregory's Outlines of Chemistry, Abel and Bloxam's Handbook of Chemistry, Galloway's Qualitative Analysis.

Subject XII -Geology.

1. The division of rocks into three great classes, aqueous, igneous, and

metamorphic.

- 2. The mode of formation of stratified rocks, -marine strata-delta formations - freshwater beds, - the sign by which you can distinguish
- 3. The mode of occurrence of igneous rocks, ashes, lavas, and dykes.

4. Volcanoes and volcanic phenomena.

5. The theory of central heat.

6. Elevation and depression of land.

7. The ordinary mineral substances that enter into the composition of

Fossilization of organic bodies.

9. Table of geological formations, including those larger divisions absent in Britain.

Theory of metamorphism of rocks.

British Strata.

1. Description of the Cambrian strata and Silurian strata, their lithological characters, disturbances and chief fossils.

2. Description of the old red sandstone and Devonian rocks, character and fossils. Origin of cleavage. Slate and slate quarries, buildingstones, limestones, and marbles.

3. The carboniferous limestone and coal measures. Character, fossils, and mode of formation. Origin of the coal of the coal-measures. and its mode of occurrence. Mode of occurrence of the ironstone of the coal measures. Various kinds of coal, and the relation of anthracite coal to disturbance of strata. Lime quarries, marbles. and building stones. Clay pits and potteries of the carboniferous strata. Fire clay. Alum shale.

4. The Permian rocks. Their strategraphical relations to the underlying strata, composition of rocks, fossils, and building-stones.

5. The new red sandstone (or Trias), its subdivisions, fossils, buildingstones, sand pits, rock salt, and brine springs.

6. The Lias. Its subdivisions, chief fossils, building-stones, and other

hydraulic limestones, and clay pits.

7. Oolitic rocks. Subdivisions, leading fossils, building-stones. Limestones. Clay pits, and other economic products.

8. The Purbeck and Wealden strata. Origin, subdivisions, chief fossils. building-stones, and marbles. Ironstones and limestones. Clay pits.

Subdivisions, lithological characters, fossils, 9. Cretaceous rocks. building stone of lower greensand. Gault, its phosphatic nodules and general uses. Upper greensand, chalk, &c. Building stones. Origin and uses of chalk-flints.

10. Eccene, or older Tertiary beds. Subdivisions, alternation of marine and freshwater beds, chief fossils, limestones and building stones.

clays for bricks and potteries.

11. Crag. Its subdivisions, chief fossils, phosphatic remains.

12. Disturbance and denudation of strata.

13. Unconformities, faults, and fractures.

- 14. The causes of gaps in the succession of strata, or of breaks in the succession of life in time.
- 15. Water-bearing strata, and underground drainage. Artesian and

16. British rocks in which ores of metal are found, and the general mode of occurrence of these ores in beds or lodes.

17. The rules that ought to guide the miner in sinking for coal and other minerals, when the beds in which they lie are concealed by over-lying and unconformable strata.

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18. The occurrence of stream tin, gold, &c., in superficial detritus.

19. The chief differences in the nature and mode of occurrence of various formations in areas widely separated from each other.

Text-books.—Lyell's Principles of Geology; Lyell's Elements of Geology; Phillips' Manual of Geology; Jukes' Manual of Geology; Page's Introductory Text-Book; Page's Advanced Text-Book.

Subject XIII.—Mineralogy.

A. Instruction in this subject should commence with a distinct understanding of the characters by which minerals, properly so called, are to be distinguished from other inorganic substances, and of the position of this science in relation to the collateral sciences of

physics, chemistry, and geology.

B. Crystallography, as the essential means of appreciating the forms naturally assumed by almost all inorganic bodies, must commence with the needful geometrical definitions, proceed to the grouping of the various crystalline forms into systems, consider the laws by which the derivation of one form from another within the limits of the same system is determined, and explain the combination of various simple forms in the faces exhibited by compound crystals. It is also important to study the deviations from regularity which are commonly presented in nature, and the methods of measuring those elements which remain constant.

c. The variouskinds of aggregation exhibited by crystalline substances are also to be considered, especially with reference to masses of the

useful minerals, and of crystalline rocks.

D. Next in order will follow the other physical characters of minerals: 1st, in relation to their substance, as cleavage, fracture, hardness, and specific gravity: 2ndly, in relation to the effects of light, as transparency, refraction, lustre, and colour; 3rdly, as to their electric and magnetic properties.

E. The chemical characters of minerals, and the most convenient modes of testing them; 1st, by aid of the blowpipe; 2ndly, by the

moist way.

F. Pseudomorphism, or the remarkable phenomena presented by minerals which have the composition of one mineral coupled with the form

of another.

G. The physiography or systematic description of minerals. This last division should include all the more remarkable varieties as well as species, and should take especial note of the modes and places of occurrence, as well as of the association of particular groups of minerals in certain veins or formations.

As text-books may be recommended—

Professor Ansted's Elementary Course of Mineralogy and Geology. London, 1856.

Nicol's Elements of Mineralogy. Edinburgh, 1858.

Dana's Manual of Mineralogy, 1851.

Bristow's Dictionary of Minerals. Longman & Co. 1861.

For more advanced students—

Brooke and Miller's Mineralogy. London, Longman, 1852.

Rev. W. Mitchell, in Orr's "Circle of the On Crystallography. Sciences." London, 1856.

Dana's System of Mineralogy. 4th edition. Putnam, 1854.

Naumann's Mineralogie. Leipzig. Williams and Norgate, London.

Breithaupt's Paragenesis der Mineralien. Freiberg, 1849. Haidinger's Handbuch der Mineralogie. Vienna, 1845.

When it is intended to teach this subject with special reference to the practical working of minerals, the physiographical part will be occupied more particularly with certain of the useful species and their associated substances, and the following works may be consulted:—

W. J. Henwood on the Metalliferous Deposits of Cornwall and Devon,

1843.

Bischof, Chemical and Physical Geology, translated by the Cavendish Society. 1854.

Subject XIV.—Animal Physiology.

The field presented by Natural History is such an exceedingly wide one, that candidates are advised to confine their studies to the subjects enumerated below, and to master these as thoroughly as possible. And as in the Natural Sciences, the knowledge which is obtainable by mere reading is of very little value, candidates are particularly recommended to study nature for themselves, and to become personally acquainted with the primary facts of Biological Science. Thus in Physiology, the fundamental truths relating to circulation, muscular contraction, and nervous action, may all be readily exemplified by simple experiments upon the common frog; and in Systematic Zoology and Botany, the careful study of the structure of the animal and vegetable forms enumerated under the head of "types" will furnish a better conception of the animal and vegetable worlds than any amount of mere-reading. Candidates will therefore be expected to be thoroughly and practically acquainted with the fundamental facts of Physiology, and in Zoology, with all the most important and distinctive characteristics of such of these typical genera as are illustrated by British species.

Candidates should have carefully studied what is stated upon the subjects enumerated below in any good handbook of Physiology.

The general properties of living matter in respect of form, structure, and chemical composition. The meaning of the terms organ, organization, function, development. The difference between high and low organization. The division of physiological labour.

Why the living organism wastes. The difference between vital and putrefactive decomposition. The conditions and ultimate products of vital decomposition. The living body considered as a

machine performing a certain amount of work.

Why food is necessary. The difference between the food of plants and that of animals. The nature of the substances which constitute the food of man. The proximate chemical composition of milk, flour, meat, butter, potatoes, oatmeal, peas, rice, tea, coffee, beer, wine, and spirits; and the distinction of the proximate elements of each into nutritious and innutritious.

Why digestion is necessary, and how that function is performed in the human organism. The structure of the organs by which the following substances are formed, and their uses: saliva, gastric juice, pancreatic juice, bile. How the nutritious products of digestion are separated from the excrementitious residuum. The process of absorption. The means by which absorbed matters are conveyed to all parts of the organism. The structure and composition of human blood. The course and mechanism of the circulation.

Why the elimination of waste products is necessary. Excretion of carbonic acid. The mechanical and physical principles involved in the performance of the respiratory process in man. The excretion of urea and uric acid. The structure of the urinary apparatus, and the mechanical and physical principles involved in its action. The excretion of water as a part of the foregoing processes, and as effected by the skin. The structure and other functions of the skin. The mutual relations of the three great excretory apparatuses.

The mutual relations of the three great excretory apparatuses.

The conditions and sources of animal heat. The circulatory system of man viewed as a hot-water warming apparatus. The fuel

of the animal economy and its sources.

Animal mechanics. The human body as a locomotive apparatus.

The structure of bones and joints. The structure and properties of muscle.

The structure and functions of nervous matter. The offices of the spinal cord and brain. The nature and mode of action of the sensory organs. Reflex action. Habit, as acquired reflex action. Instinct. Intellectual and emotional operations.

The nature of death, and the difference between general and local death.

Local death:—1st, as a part of life; e.g. moulting, shedding of skin and teeth. 2nd, as opposed to life; e.g. sloughing and mortification. General death:—1st, as the natural conclusion of life. 2nd; as arising from disease or injury. Usual commencement of death in the nervous centres, the heart or the lungs.

Reparative processes:—1st. Local, as exhibited in the reproduction of lost parts, healing of wounds, &c. 2nd. General, as shown in the reproduction of the individual by sexual generation. The origin and development of the embryo. The nutrition of the fectus and of the infant. Hereditary transmission, and the modification of physical and mental characters by education, as the basis of a rational belief in the possibility of human progress.

Subject XV.—Zoology.

1. Candidates should have carefully mastered the definitions of the sub-kingdoms, classes, and orders of the Animal Kingdom. They should understand and be able to explain the meaning of the terms employed in such definitions; and they should be able to refer any specimens that may be placed before them to their proper classes.

2. Candidates should be able to give fair answers to questions relating to any or all of the following subjects, and they should be able to identify, refer to their proper orders, and if called upon to do so, describe, the objects enumerated in each section under the head of "types." In almost all cases these "types" are British animals.

By the term Natural History, of such and such an object, is meant such an account of it as is to be found in any standard modern work on Zoology.

i. The structure and mode of multiplication of infusorial animalcules and Foreminifera. The arguments which have been adduced for and against spontaneous generation. The luminosity of the sea, and the nature of the creatures which chiefly cause it. The natural history of the sponge of commerce. Types—Spongia, Verticella.

ii. The meaning of the terms, zoophyte, coral, coralline. Natural history of the red coral of commerce. Common coral and coral reefs. What such reefs are, where they are formed, and how they grow. Natural history of the common freshwater polype, or hydra, and of the "jelly fishes," or "meduse" of the sea. A sexual multiplication as exhibited by these creatures. Types—Hydra, Sertularia, Plumularia, Actinia, Corallium, Fungia, Oculina.

iii. Starfishes, sea urchins, and Holothuriæ; their structure and habits, and the metamorphoses which they undergo. Natural and economical history of Trepang. Types—Uraster, Echinus.

iv. Natural history of the earthworm and the leech. Intestinal worms; their structure, propagation, and mode of entrance into animal bodies. Natural history of the Rotifera. Types—Lumbricus, Hirudo, Distoma, Tania, Ascaris.

v. Natural history of Crustacea. The lobster and crayfish, as exemplifying morphological and teleological laws. The process of ecdysis. Barnacles, acorn shells, and fish lice, as cases of extreme

metamorphosis. The water flea as exemplifying a sexual multipli-cation. Types—Cancer, Homarus, Astacus, Oniscus, Daphnia, Cyclops, Lepas, Balanus, Argulus.

vi. Natural history of spiders, scorpions, and mites. The "itch insect," centipedes, and millipedes. Types-Tegenaria, Scorpio,

Scolopendra, Julus.

vii. Insects; their mode of breathing as contrasted with that of The structure of their wings, and the spiders and crustaceans. mechanism of flight. The parts of the mouth and their modifications in beetles, bees, butterflies, bugs, and gnats. Structure of the eyes. Nature of stings, saws, and ovipositors. Natural and economic history of the blistering beetle, of the silk moth, of the bee, of the cochineal insect. Natural history of plant lice, of bugs, fleas, and lice. The house fly, blow fly, and gnat; wasps, humble bee, ichneumon flies; "black beetles," crickets, and locusts. The metamorphoses of insects. Types-Melolontha, Blatta, Libellula,

Phryganea, Coccus, Aphis, Bombyx, Apis, Vespa, Musca.

viii. The characteristic peculiarities of the nervous, circulatory, respiratory, and locomotive organs of mollusks in general. Organization of "sea mat" (Flustra). Ascidians and "lamp shells" (Terebratula). Natural history of fresh-water and marine mussels. Nature of mother of pearl. Formation of pearls. Pearl fishery. Natural and economical history of the oyster. Organization of snails and slugs, periwinkles, limpets, whelks. Development of the young Nidamental capsules. Cuttlefishes and squids. of the latter. of the latter. Musineness capsus.

Paper nautilus. Pearly nautilus. The shipworm and Pholas.

Mechanism by which mollusks bore. Types—Flustra, Ascidia, Terebratula, Unio, Mytilus, Ostrea, Pecten, Helix, Patella, Littorina, Buccinum, Chiton, Sepia, Loligo, Argonauta, Nautilus.

ix. Circulatory, respiratory, and reproductive organs of fishes. Their dentition. Natural and economical history of the lamprey, sprat, sardine, herring, pilchard, salmon, trout, eel, cod, haddock, sole, flounder, turbot, mackerel, tunny, sturgeon, skate, ray, dog fish, shark. Electrical fishes. Fishes which are capable of living in air. Pisciculture, or the artificial breeding of fishes. Types-Amphioxus, Petromyzon, Syngnathus, Cyprinus, Perca, Accipenser, Lepidosteus, Raia, Spinax.

x. Natural history of salamanders, newts, frogs, and toads, Metamorphoses undergone by their young. Types-Salamandra.

Triton, Rana.

xi. Circulatory and respiratory organs of reptiles as distinguished from those of fishes and amphibia. Natural history of snakes, lizards, crocodiles, turtles, and tortoises. Tortoise-shell. Shedding of the skin in reptiles. Types—Coluber, Pelias, Anguis, Lacerla, Crocodilus, Testudo, Chelone.

xii. Organs of locomotion, respiration, voice, circulation, and reproduction of birds. Structure and mode of growth of feathers, Development of the fowl's egg. Artificial hatching. Migration. and instincts of birds. Natural history of domestic birds; of the ostrich, the apteryx, the penguin, and the dodo. Types—Falco, Corvus, Columba, Picus, Phasianus, Ardea, Struthio, Anser.

xiii. Organs of respiration, circulation, and reproduction of mammals. Production and nutrition of their young. Placental and implacental mammals. Nature of milk and of the lacteal glands. Peculiarities in the dentition of mammals. Natural and economic history of the domestic mammals; of the ivory and fur yielding mammals; of seals; of whales. The hybernation and migration of mammals. Characters of the orders of mammals. Types-Cercopithecus, Vespertilio, Erinaceus, Lepus, Elephas, Sus,

Cersus, Bos, Ovis, Felis, Phoca, Phocana, Dasupus, Hulmaturus. Ornithorhynchus.

xiv. The distinctive peculiarities of man. The characters of the principal races of mankind, and their geographical distribution.

Text-books for Physiology.—Carpenter's Animal Physiology, Bohn, 1859; Dr. Kirke's Manual: Andrew Combe's Physiology applied to Health and Education. For Zoology .- Dallas's Natural History of Animals; Orr's Circle of the Sciences; Gosse's Manual of Marine Zoology: Professor Green's Manual of the Protozoa.

Subject XVI.—Vegetable Physiology and Economic Botany.

In this department the candidate will be expected to answer correctly questions on the following points:—

1. The properties of the principal elements entering into the composition Carbon, oxygen, hydrogen, nitrogen, sulphur, phosphorus, chlorine, iodine, silicon, potassium, sodium, calcium, iron.

2. The composition and properties of the compounds forming the principal part of the structure of plants. Cellulose, starch, dextrine, sugar, fixed oil, gluten, albumen, caseine. The saline compounds forming the ashes of plants.

3. The composition and properties of peculiar vegetable products. latile oils. Acids. Colouring matters. Alkaloids. Neutral principles.

Chlorophyll.

4. The origin and growth of the vegetable cell. The tissues of plants. Cellular tissue. Intercellular organs. Epidermal tissue. Hairs.

Stomates. Vascular tissue. Woody tissue.

5. The structure and functions of the organs of plants. The root. Spongioles. Absorption and excretion. Nature of vegetable food. Structure of Exogenous, Endogenous, and Acrogenous The stem. stems. The leaf. The forms of leaves. Exhalation. Stipules and bracts. The flower. Calycine, Corollal, Staminal, and Carpellary leaves. Development and nature of pollen. Ovules or seed buds. Vegetable impregnation. Embryo. Seed. Fruits; their nature and forms. The nature of the reproductive organs in flowerless plants.

6. The composition and nature of vegetable substances used by man Distinctions between heat-giving and flesh-forming foods. Structure and geographical distribution of plants yielding starch.

sugar, oil, gluten, albumen, and legumin.

7. Properties of vegetable substances used in the arts and manufactures. Vegetable secretions used as dyes.—Indigo, madder, logwood, red sanders wood, quercitron, alkanet, arnotto, gall-nuts, myrobolans.

8. Materials used in the manufacture of textile fabrics.—Cotton, flax,

hemp, coco-nut, jute, New Zealand flax.

9. Principal forms of timber trees, and their uses.—Oak, mahogany, teak, pine, &c.

10. Nature of tanning principles and plants yielding tannic acid.—Oakbark, valonia, catechu, kino, divi-divi, betel-nut.

11. Gums, oils, and resins used in arts.—Gum arabic, benzoin, rosin, turpentine, camphor, essential oils, coco-nut oil, palm oil, other fixed oils, caoutchouc, gutta pertsha.

12. Substances obtained from the vegetable kingdom and used as medicines.—Opium, quinine, tobacco, jalap, scammony, gentian, aloes, rhubarb, senna, ipecacuanha, sarsaparilla, castor-oil, assafœtida,

myrrh, nux vomica, hemlock.

Text-books for Vegetable Physiology and Economic Botany.—Henfrey's Elementary Course of Botany; Van Voorst. Carpenter's Vegetable Physiology, edited by Dr. Lankester; Bohn. Schleiden's Principles of Scientific Botany; Bohn. A Manual of Structural Botany by M. C. Cooke. Archer's Popular Economic Botany; Reeve and Co. Lindley's Medical and Œconomical Botany: Bradbury and Evans.

Subject XVII.—Systematic Botany.

In this department the candidate will be expected to demonstrate the structure of plants from living specimens.

1. The distinctions between the three great classes of plants, Dicotyledons, Monocotyledons, and Acotyledons. Also of the groups Gymnosperms, Rhizanths, Dictyogens, Acrogens, and Thallogens.

2. The characters of the following orders of British plants should be mastered, and the typical genera recognized, and their structure

understood.

3. Algæ. The natural history and uses of sea-weeds. The microscopic structure of diatoms and desmids. Nature of the reproductive organs in this order. Types-Navicula, Desmidium, Conferva, Fucus, Ceramium.

4. Lichens. The natural history and uses of lichens. Structure of their reproductive organs. Types-Graphis, Collema, Parmelia.

5. Fungi. The natural history of mushrooms, puff-balls, moulds, blights, and toadstools. Their uses in nature. Types-Agaricus, Bovista, Torula, Aspergillus, Morchella, Mucor.

6. Mosses. The nature of their reproductive organs. Types - Bryum,

Sphagnum, Funaria.

- 7. Ferns. Nature of their rhizomes. Herbaceous and tree ferns. History of Development, and nature of reproductive organs. Types
- -Polypodium, Hymenophyllum, Osmunda.

 3. Graminaceæ. The history of grasses and their uses. Nature of the flower in this order. Useful plants of the order. Types—Phleum, Hydrochloa, Panicum, Agrostis, Arundo, Spartina, Avena, Festuca, Hordeum, Triticum, Secale, Nardus, Anatherum.

9. Cyperaceæ. Sedges. Types—Carex, Scirpus.

The lily tribe, its useful properties. Types—Tulipa, 10. Liliaceæ. Ornithogalum, Muscari.

11. Amaryllidaceæ. The family of the narcissus, snow-drop, snow-flake. Types—Narcissus, Galanthus.

12. Orchidaceæ. The orchis family. Structure of reproductive organs.

Types—Orchis, Goodyera, Malaxis, Cypripedium.

13. Amentaceæ. The family of the hazel, chestnut, oak, willow, birch, beech, poplar, and hornbeam. The uses of these plants as timber, &c. Types-Quercus, Corylus, Fagus, Castanea, Betula, Myrica, Salix, Populus.

14. Urticaceæ. The nettle and hop tribe. Its relations to Moraceæ. Artocarpacæ, Cannabinaceæ, and Ulmaceæ. The nature of the stings of Urtica, and the bitter principle of the hop. Types—Urtica,

Parietaria, Humulus.

15. Euphorbiaceæ. The spurge family. Foreign forms and their uses. Croton, Cascarilla, Ricinus, Janipha. Apetalous and Polypetalous forms. Types—Euphorbia, Buxus.

The buckwheat and rhubarb tribe. Types—Poly-16. Polygonaceæ.

gonum, Rumex.

17. Primulaceæ. of stamens. The primrose family. Theory of the peculiar position Types—Primula, Lysimachia.

18. Labiatæ. The dead nettle tribe. Peculiar properties of this order. Types-Mentha, Salvia, Thymus, Nepeta, Lamium, Teucrium.

19. Scrophulariaceæ. The scrophularia tribe. Nature of the poisonous properties of the order. Types—Scrophularia, Digitalis, Verbascum, Euphrasia, Veronica, Melampyrum.

The borage tribe. Peculiarities of their epidermis. 20. Boraginaceæ. Useful species. Types-Cynoglossum, Borago, Echium, Myosotis

Lithospermum.

21. Solanaceæ. The tribe of deadly nightshade, henbane, tobacco, and potato. Useful and poisonous species. Types-Solanum, Atropa, Hyoscyamus, Datura.

22. Ericacea. The heath tribe. Its distinction from Epacridacea.

Types—Erica, Arbutus, Vaccinium, Pyrola, Monotropa.

23. Compositæ. The composite family. The number of species and geographical distribution. Structure of the sub-orders Asteraceæ, Cichoraceæ, and Cynaraceæ. Types—Tussilago, Aster, Inula, Gnaphalium, Bellis, Artemisia, Achillea, Carlina, Carduus, Cichorium, Leontodon, Lactuca, Crepis.

24 Stellatæ. The Stellate tribe. Its relation to Cinchonaceæ and Caprifoliaceæ. The properties and useful plants of Cinchonaceæ.

Types-Galium, Rubia.

25. Umbelliferæ. Úmbel bearing plants. Character of inflorescence and flowers. Nature of fruit. Structure of cremocarp. Properties of the order. Types—Hydrocotyle, Sanicula, Eryngium, Apium, Sium, Æthusa, Œnanthe, Crithmum, Angelica, Pastinaca, Daucus, Torilis, Scandix. Conium, Coriandrum.

 Cucurbitacea. Melon, cucumber, and gourd family. Useful plants of this order. Type—Bryonia.

27. Rosaceæ. The rose, apple, cherry, and plum tribe. Forms of the fruit. The useful plants of this order. Types—Prunus, Spiræa,

Fragaria, Rubus, Geum, Rosa, Cratægus, Pyrus.

28. Leguminosæ. The bean, pea, and clover family. Principal divisions of the family. Structure of the flowers and fruits. Useful plants of the order. Types—Ulex, Trifolium, Vicia, Astragalus, Ornithopus.

 Crucifera. Cabbage, turnip, and mustard tribe. Structure of the flowers and fruits. Useful plants of the order. Properties. Types— Nasturtium, Alliaria, Brassica, Sinapis, Armoracia, Iberis, Isatis,

Crambe, Cakile.

 Papaveraceæ. The poppy tribe. Properties and mode of collecting opium. Nature of fruit. Types—Papaver, Glaucium, Chelidonium.

31. Ranunculaceæ. The crow-foot tribe. Structure of abnormal genera; Aconitum, Aquilegia, and Delphinium. Nature of poison in order. Types—Ranunculus, Clematis, Helleborus, Pæonia, Anemone. Text-books for Systematic Botany.—Lindley's Vegetable Kingdom. For

British Botany.—Bentham's Handbook of the British Flora, or Babington's Manual of British Botany.

Subject XVIII.—Mining.

The Art of Mining embraces so wide a field of study that equal practical proficiency in its various branches is not to be expected; but those who wish to gain a general knowledge of it may be recommended to

direct their attention to the subjoined heads, viz.:

1. Geology and Mineralogy, more particularly those portions of the sciences which bear on the following subjects,—the nature and position in the earth's crust of the useful minerals, the classes of rock with which they are severally associated, the special character of heaves, throws, troubles, and all kinds of dislocation; the particular differences between beds and lodes, and their minerals, and the chief features of irregular repositories.

2. The methods of prospecting and searching at surface for ores and

other minerals.

3. Breaking of ground; the various implements employed, their form, dimensions, and weight; boring for shots; the various modes of firing charges. Heavy charges, how calculated and fired; rules for ensuring safety.

4. Deep boring, under what circumstances applicable,—apparatus for;

description of varieties in use; lining of bore-holes.

5. Management and supervision; payment of men employed at mines, at surface and underground, varying in principle with the different

classes of operation; reasons for tut-work or piece-work, and tribute or bing-tale under different circumstances. Calculations for cost of driving,

sinking, tramming, &c.

6. Physical principles of ventilation; practice of mines where simple natural ventilation is employed; ventilation of large areas and of deep or complicated workings by guiding the natural current; artificial means, and their details, for promoting ventilation. Precautions to be taken under specially dangerous conditions.

7. Illumination, of various kinds, their economy; safety lamps in all their best modifications; circumstances under which they should be

employed; precautions in their use.

8. Mechanical division of the subject. Strength of materials used in mines; human and horse power, principles and construction of machines to which they are applied. Hydraulic machines: construction of the water-wheels, turbines, and pressure engines most suitable to the various operations of mining. Steam engines, for pumping and for winding; arrangement and construction of the varieties most in use. Form and dimensions of boilers. Pumps employed in mines, mode of placing them; construction of the lifts; materials and details of the rods, setoffs, counterbalances, cisterns, and catches. Circumstances under which dams are erected in shafts or levels; mode of building them.

Tubbing of water from shafts; conditions under which it may be done; details of the operation with various materials, wood, brick, stone,

cast and wrought iron.

Rails, waggons, and tubs for underground conveyance; employment

of horses and of fixed steam engines for this purpose.

Raising of the mineral through the shafts; various methods in use; chains, ropes (of hemp or wire), their weight, &c. Details of the best application of drums, cages, guides, keeps, and safety doors. Pulleys and shaft frames or poppet heads; protection against over-winding; safety clutches, &c. in case of breakage of rope.

9. Opening of ground; quarries and open work; driving of levels, various dimensions and directions according to circumstances; sinking of shafts, inclined or perpendicular; advantages of either kind under certain conditions; means of securing levels and shafts by timber or by walling; details of the various methods. Driving or sinking in heavy

or running ground.

10. Working excavations; plan of laying them out, and means of security to be adopted whilst they are kept open. This will include the stoping of metalliferous veins, and the various modifications of post and stall, long-work, &c., which are applied to stratified deposits.

11. Travelling in shafts; prevention of accidents by proper fitting and dividing; mode of placing ladders and sollars; lifting machine for men,

construction and advantages of.

12. Dressing of minerals. Arrangement of dressing floors. Construction of crusher and stamps; washing of coal; jigging, concentration, and separation of metallic minerals.

The student may be advised among other sources of information to

consult the following works:-

De la Beche's Report on Cornwall and Devon. Greenwell's Treatis: on Mine-Engineering. Dunn on the Winning and Working of Collieries. Hedley on Colliery Working and Ventilation. Evidence before Committees of the Houses of Lords and Commons on Accidents in Mines. Reports of H.M. Inspectors of Coal Mines. Transactions of the Northern Institute of Mining Engineers.

Subject XIX.—Metallurgy.

I. Introduction.

On certain physical properties of metals. Action of heat, specific gravity, crystallization, fracture, malleability, ductility, tenacity, con-

ductivity of heat and electricity, opacity, lustre, colour. General considerations on metallurgical processes. Modes of occurrence of metals in nature, ores, reduction, smelting, roasting, liquation, slags.

II. Fuel.

General remarks, calorific power, calorific intensity, classification of fuels, wood, peat, lignite, coal, charcoal, coke, gaseous fuel and gas furnaces, charcoal burning, coke burning, typical varieties of coke ovens, comparison of fuels with respect to calorific power. This important branch of the subject is treated with much detail.

III. Refractory materials employed in the construction of furnaces, crucibles, &c.

Fire-clays British and foreign, crucibles of various kinds, plumbago and its application to crucibles, manufacture of crucibles, fire-bricks, silica and its applications, Dinas fire-bricks, sand and sandstones.

IV. Special Metallurgy.

Copper.—Compounds of special importance in the metallurgy of this metal fully described, such as the disulphide, oxides, &c., ores of copper, copper-smelting in reverberatory and blast furnaces, reactions occurring in the process, kernel-roasting, 'wet' methods, of extracting copper from its ores, assaying of copper ores by 'dry' and 'wet' methods,

ship sheathing.

Zinc.—In describing the metallurgy of zinc and the following metals, the same plan will be followed as in describing the metallurgy of copper, that is to say, the compounds of special metallurgical importance will be first considered in detail, as well as the reactions upon which the various processes of smelting essentially depend, and the construction of the furnaces will be fully explained. Ores of zinc, English, Belgian, Silesian, and Carinthian methods of extraction, assaying of zinc ores brass, its history, properties and manufacture.

· Lead.—Ores of lead, lead smelting in the 'ore-hearth,' low blast and reverberatory furnaces, lead-fume and various methods adopted for its

condensation, assaying of lead ores.

Silver.—Ores of silver; smelting of silver ores with lead; cupellation; desilverization of lead by Pattinson's process, also by that of Parkes; treatment of argentiferous copper by liquation; extraction of silver; amalgamation, the old Freiberg method and the Mexican; Ziervogel and Augustin's 'wet' methods; treatment of argentiferous copper-regulus; alloys of silver and copper; standard silver; assaying of silver ores and alloys.

Gold.—Modes of occurrence of gold in nature; extraction by amalgamation and by smelting with lead; chlorine-water as a solvent for the extraction of gold from certain ores; separation of gold from silver or parting by nitric and by sulphuric acids; alloys of gold with the preceding metals; standard alloys; assaying of auriferous ores and

alloys.

Mercury.—Ores of mercury; extraction in the Almaden, Idrian, and Hähner furnaces; in retorts in admixture with reducing agents; assaying

of the ores of mercury.

Antimony.—Ores of antimony; liquation of the native sulphide and its subsequent reduction by iron or other agents; alloys of antimony, type metal, &c.; assaying of the ores of antimony.

Bismuth.—Mode of occurrence in nature; its extraction from ores

containing it by liquation; alloys of bismuth.

Nickel.—Ores of Nickel; modes of extraction, generally by a com-

bination of 'dry' and 'wet' processes; alloys of nickel, especially those known as German silver; assaying of nickeliferous ores and alloys.

Cobalt.—Ores of cobalt; smelting and preparation of zaffre and cobalt colours, smalts, &c.; separation of nickel; assaying of cobalt ores.

Arsenic.—Mode of occurrence in nature; arsenious acid or 'glass' of arsenic, generally obtained as a secondary product in the treatment of certain other ores, such as those of nickel, cobalt, &c.; modes of condensation of arsenical fumes; preparations of arsenical 'glass,'

Tin.—Ores of tin; smelting in reverberatory and blast furnaces; tin refining; varieties of tin in commerce; alloys of tin, with the preceding

metals, bronze, gun-metal, bell-metal, &c.; assaying of tin-ores.

Iron.—Malleable iron; steel; pig-iron; ores of iron, direct extraction of iron in the malleable state from the ore; smelting of iron in the modern-blast furnace; construction of blast-furnaces and blowing machines; economic application of the waste gases; conversion of pig into bar iron in open hearths and in the reverberatory furnace; manufacture of steel by various methods. This department of the subject will be treated at considerable length.

Various Metals.—Platinum and its associated metals; cadmium;

sodium; aluminium; tungsten; titanium; manganese.

Subject XX.—Navigation.

 Elementary Principles.—Problems relating to latitude, longitude; differences of latitude, and differences of longitude.

Relation between an arc of a parallel of latitude and an arc of the equator. Principles of plane sailing and middle latitude sailing. Principles of Mercator's sailing. Mercator's chart. Principles of great circle sailing. The compage and its corrections

great circle sailing. The compass and its corrections.

(1.) Variation. (2.) Deviation. (3.) Local attraction. (4.) General theory of deviation (Towson's Practical Information, first 50 articles). Correction of courses for variation, deviation, and leeway. The log. Correction of estimated distances run for errors in the log line and glass. Plane sailing. Traverse sailing. Middle latitude sailing. Mercator's sailing, with examples.

To find difference of longitude made on a traverse. Sea journal. A day's work. Practice of great circle sailing. Circular arc sailing. Tides. Winds. Cyclones. To find bearing of a circular storm; veering of wind; heaving to; and sailing from centre of gale.

Construction of tables of meridional parts.

Description and use of sextant, with the theory, adjustments, and errors.

Note.—Candidates for certificates as teachers of Navigation will be required to possess a competent knowledge of the whole of the above syllabus, and to have obtained a certificate in elementary mathematics and passed in higher mathematics as far as spherical trigonometry inclusive.

For students.—To "pass," as far as principles of plane sailing. The

compass and correction of courses.

For honourable mention.—As far as Mercator's sailing, with examples. For third, second, and first class Queen's prizes, a proportionate knowledge of the remainder.

Subject XXI.—Nautical Astronomy.

Definitions. Time, apparent, mean, sidereal, &c. Equation of time. To express interval of mean or sidereal time in parts of sidereal or mean time respectively. To convert arc into time, and conversely. To find Greenwich date. To take out right ascension of sun for a given mean Greenwich date.

Correction of altitudes. Dip. Parallax. Refraction. Augmentation of moon's semi-diameter. Reduction of altitude of a heavenly body observed at one place to what it would have been if observed at another. The chronometer and its use, error, and rate.

Latitude by meridian altitude of sun, and fixed star.

Latitude by meridian altitude of moon. To find Greenwich mean time of moon's meridian passage. To find semidiameter and horizontal parallax of moon for a given Greenwich date. To take out from

Nautical Almanac moon's declination, &c.

To find local and Greenwich mean time of passage of a star over a given meridian on a given day. Latitude by altitude of sun, star, or moon below the pole and by pole star. Latitude by altitude of sun or other heavenly body near the meridian. Calculations of hour angles. Meridian distances. Right ascensions. Computations of time. Error and rate of chronometer. Computation of mean or apparent time at any place from observed altitude of a heavenly body. Longitude by chronometer. Error in hour angle from error in observed altitude. Variation of compass. Azimuth, altitudes, amplitudes, determination of true bearings. True azimuth from altitude of heavenly body and without observed altitude. True bearing of a point of land, &c., by observed angular distance from the sun. Variation of compass from observed amplitude of sun.

Deviation of compass, from Art. 50 to end of Towson's Practical Information. Sumner's method of finding longitude and latitude.

Method of double altitudes, Ivory's and direct. Error of chronometer by equal altitudes of sun and fixed star. To compute apparent

altitude of a heavenly body when its true altitude is given.

Methods of clearing a lunar distance from the effects of parallax and refraction. To find Greenwich date corresponding to a given true lunar distance, &c. To find the altitudes when a lunar distance is taken from altitudes before and after taking the distance. To find the longitude by a lunar. Rate of chronometer by a lunar.

Obs.—In all the above problems the demonstration of the rules as

well as accurate practical working is required.

Note.—Candidates for certificates as teachers will be required to possess a competent knowledge of all the above syllabus, and to have obtained a certificate in the elementary mathematics, and passed in higher mathematics as far as spherical trigonometry inclusive.

For students.—To "pass," a knowledge of the elementary principles,

and finding latitude by meridian altitudes of a heavenly body.

For "honourable mention," the above, with variation of compass from altitudes and azimuths, and rate of chronometer, and longitude by

chronometer, is required.

For third, second, and first class Queen's prizes, a more or less accurate

knowledge of the remainder.

Subject XXII.—Steam.

General Properties of Steam.—General effects of heat and cold, with practical applications of the principle. Law of expansion by heat not universal. Beneficial result of this anomaly. To ascertain the temperature of any substance. Pyrometer. Thermometer—Description—Graduation. Comparison of thermometers when differently graduated. Laws of cooling. Conduction. Conducting powers of bodies. Convection. Explanation of some natural phenomena by this law. Radiation. Radiating power of bodies. On what it depends. Land and sea breezes. Capacity for heat. Unit of caloric. Latent

heat. Under what circumstances heat becomes latent. Heat sole agent in melting and vaporising bodies. Calorimeter. Sources of heat. Combustion. Temperature necessary for it. Boiling point. Temperature of elastic fluids. Vapour. Formation of dew. Distinction between vapour and steam. Boiling points of fresh and salt water. Distillation. High-pressure steam. Measure of steam by atmospheres. Steam when in contact and when not in contact with boiling water. Relation between pressure, density, and temperature of steam. Specific gravity of steam. Common, superheated and surcharged steam. Priming. Analysis of sea water.

 Steam Engine.—General principles. Different kinds. Engines in use before Watt. Newcomen's engine. Its defects. Discoveries of Watt. Blowing through. Defects in atmospheric engines. Single acting and double acting engines. Expansion valve. Cornish— High-pressure or non-condensing engine. Marine steam engine. Different descriptions. Side-lever marine engine. Blow-valve. Stuffing boxes. Piston of steam cylinder. Working parts. Working of the slides, strap, gib, and cutter. Escape valve of cylinder. Parallel motion. Hall's condensers. Test cocks. Grease cocks. Grease cups of slides. Annular air-pump bucket. Annular delivery valve. Various kinds of slides. Cushioning. Lead. Lap, its effects. The eccentric. Throw and stops of ditto. To find the travel of the slide. Back-lash. Double eccentric. Throttle valve. Expansion valve and various kinds. on valve and various kinds. Barometer or condenser Method of estimating pressure by it. Errors in this gauge. method, and correction of the same. Lubricators, &c. Number of engines in a steamer. Expansion cams and gear. Feed pumps. Bilge pumps. Modes of propulsion. Paddle wheels. Pitch, Reefing. Disconnexion and immersion of wheels. Brakes.—Modes of fitting. The screw propeller. Length, angle, pitch, slip, area of screw Disconnecting and raising screw. Governors. acting engines. Gorgon-Fairbairn's double cylinder, oscillating, trunk engines, &c. Engines for screw propellers. Direct acting, with and without multiplying gear. Oscillating horizontal and trunk engines. Double acting air-pump.

Boilers.—Description. Gear connected with them. Tubular boiler.
 Number of boilers. Steam chest. Safety valve. Waste. Steam funnel and drip pipe to steam gauge. Wash or dash plates. The funnel dampers. Reverse valve. Communication or stop valve. Blow-out cocks. Circulating pipes. Brine pumps. Brine valves.

Refrigerators.

4. Calculations.—Methods of measuring efficiency of steam engines. Duty of an engine. Horse power. Mercantile or nominal horse power. Horse power from the evaporation in the boiler. De Pambour's theory. Velocity of maximum useful effect. To find evaporation of a condensing engine of given dimensions and horse power, the piston moving with a given velocity with and without expansion. To find the pressure in cylinder, knowing the effective evaporation. To find the diameter of a cylinder to work at a certain speed, knowing the evaporation. To find the evaporation in the boiler, knowing the diameter and velocity of piston and pressure of steam in the cylinder with and without expansion. Same for locomotive, Watt's engines, &c.

The screw—to find its area. Angle of the helix or thread of the screw propeller—to find the pitch. The power exerted by a screw. How far slip depends on form and dimensions of the screw. Motion of paddle-wheels, &c. Consumption of fuel. Measure of locomotive performance of marine steam engines. To find the angle the

crank has moved through when the piston is at a given distance from the top of the stroke. Amount of work developed by crank in a half-revolution—length of radius-bar in side lever engine. Work done in the up and down stroke of the air pump. The best temperature for the condenser of a steam engine. Qualities of fuel, &c.

 Practical working.—Getting up steam. Mode of starting. Working engines at moorings. Priming—causes and remedies. Banking up and putting back fires, &c. Duties to machinery when under steam, boiler, fires, &c. Injection pipes. Kingston's valves. Leaks in engines. Bearings of engines. Expansive working. Management of fuel. Damages and repairs to boiler, &c., after accidents.

Duties to engine, &c., on arriving in harbour.

6. Indicator.—The ends it fulfils. Description. Atmospheric line. Method of taking a diagram. The general configuration of diagram to be expected under various circumstances. The slide-diagram. Examination of Indicator-diagram when steam is throttled; when expansive gear alone used, and in other cases. To ascertain the horsepower of an engine by means of the indicator. To find quantity of water evaporated. Friction of steam engine without load. Diagram when there is no condensation. Diagram showing the relative motions of slide and piston at every point of the stroke.

Dynamometer. To find horse-power of engine by means of it.

The text books specially recommended are—The Marine Steam Engine, by Professor Main and Mr. Brown, R.N., Longmans and Co.; Main and Brown's Indicator and Dynamometer; De Pambour's Theory of the Steam Engine.

Note.—No certificate as a teacher of steam will be given unless the candidate has obtained a certificate in elementary mathematics and theoretical mechanics; and no first grade certificate, unless he has taken a certificate in higher mathematics.

Subject XXIII .- Physical Geography.

The knowledge included in this subject embraces:-

a. A general acquaintance with astronomy, so far as it relates to

terrestrial phenomena.

b. Distribution of the land and water; forms of the great continents; the general structure of land with regard to mountains, table lands, plains, deserts, islands, &c.

c. The ocean; its physical and chemical characters, temperature, depth, waves, tides, tidal bore, progress of the tide wave, ocean

currents, and soundings.

d. Inland waters, including the phenomena of springs, rivers, lakes, and influence of the distribution of inland waters upon commerce.

e. Winds, including land and sea breezes, trade winds, variable

winds, law of storms, cyclones, &c.

f. Climate: physical causes which determine climate, isothermal

lines, and temperature tables.

g. Distribution of plants and animals, especially as their produce is turned into articles of commerce; and classification of the races of man.

h. Information on the physical geography of the British and Colonial Empire of Great Britain, with especial reference to exports and imports.

LIST of SCIENCE SCHOOLS and CLASSES, showing the NUMBER of STUDENTS under Instruction in 1863-64, and NUMBER of MEDALS and PRIZES obtained.

Navigation Schools not examined in May, and receiving payment only under the Minyle of 14th May 1884, and therefore not counted among the Science Schools, are put

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Bury	Athenseum	Hildyard, C. F.	Bunting B.	{ Mellor, J }	88	#	<u>.</u>	: :		:	:
Cheltenham - Y	Young Men's Christian As-	Downing, James -	Moore, H. J.	Notcutt, W. L.	8	118	 83	<u>:</u> :		:	:

•	Chester - Christohurch Crewe	• • • •	Mechanics' Institute Working Men's Institute Mechanics' Institute	Frost, M. Lemmon, John Ramsbothsm, J.	Harris, Rev. J Jenkins, H. Stubbs, T.	Davidson, E. A. Judd, W Davidson, E. A.	828		288 289 399 399	=====================================	. 	15	.: :	1 G.,2 B.	
	Droylsden -	. •	Educational Institute	Christy, Richard -	Blackburn, J	{Hartley, J }	<u>.</u> :		- .		_: 	:	:	· :	
	Dudley‡ - Dukinfield	, ,	Mechanics' Institute Village Library and Read-	Rudge, S Woolnough, C	Stokes, J Kynder, J. B	Jones, J	==-		 89	<u>ૹઃ</u>	∞:	∞ :	::	::	
	Eastington -	١	ing Rooms.	Peters, Rev. Thomas	Hooper, C. H.	Pullen, M.	•:	_	_ <u>:</u>	<u>:</u>	:	:	:	:	
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	Falmouth	•	National Schoolroom	Carne, Wm	Hodges, Sidney	Shaw, H. C	<u>.</u> :		: 8	<u>:</u>	:	:	:	:	
	Glossop - Glossop	1,1	Working Men's Institute - Littlemoor Mechanics' In-	Teague, Rev. J Atkin, Rev. T	Bradbury, E Wood, Saml	Cooper, Wm	••••		88 :::	::	::	::	::	::	
	Gloucester -	•	stitute. Blue-cost School	Waghbourn, T. Bu-	Fowler, Rev. H.	Jeffery, W.	2		<u> </u>	<u> </u>	12	8	:	:	
	Greenwich .	•	Rooms of Society for Diffu-	chanan. Purvis, P.	Jordan, C. H	Jones, Thomas	•		 92	<u>:</u>	:	:	:	:	
	Gulworthy -	•	sion of Useful Knowledege. Duke of Bedford School	Mitchell, Rev. J. B	Phillips, W.	Pearce, R.	<u>ಷ</u>		: 21	•• •	:	:	:	:	_
	Halifax -	•	Working Men's College	Akroyd, Edward	Gibb, G.	Sarmain, G.	ផ		38 17	<u>:</u>		<u>6</u>	. :	:	
	Haslingden .	•	The Institute -	Thompson, Rev. R.	Binns, John .	Meaden, H. P.		_	<u>:</u>	92	<u>8</u>	83	1 8.	:	
	Huddersfield- Hull Hulme	• • •	Mechanics' Institute Trinity House Schools Christ Church Institute	Sykes, John Collinson, W. Gaskill, J.	Rhodes, Geo. W. Wilson, E	Jarmain, G. Scaping, Zebedee . Hartley, J.	8 53		888 8 24 8 : 13	: 23 :	<u> </u>	400	. : :	:::	
	Kidderminster Kinver	• •	Mechanics' Institute National Schoolroom	Tinter, G Wharton, George	Greenwood, J Bolton, Thos	Packer, M. W. Packer, M. W.			2 7 10 ::	4:		21	:::	::-	
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3008	London:— Bethnal Green - Bethnal Green - Gt.OrmondStreet		Birkbeck Schools St. Matthew's National School Working Men's College	Rogers, Rev. W. Handsard, Rev. S. Rev. F. D. Morris	Rüntz, G Halliday, J Litchfield, R. B.	Pike, R. W Simpson, B Tate, R	234		7887 11 : 8	:2:	= :e	4 0 :	:::		
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List of Science Schools and Classes, &c.—continued.

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Secretary		Whittard, C.	Ross, John Hoskins, W. H.	Fieldwick, T. A. Webb, W. H.	Brooker, John -	Brooker, John - Huntington,	Jarrett, Albert -	Noar, Wm. Mellor, James - Taylor, Wm.	Waddington, J. Bentley, Buzi Carse, Adam	Ciapham, K. C Gordon, James Evans, George - Thurlow, R	Taylor, Henry - Walters, Rev. W.	Bailey, T.	Sutherland, J. Skinner, J. W.
Chairman.		Curtis, J. C.	Fleming, Rev. W. Bogers, Rev. W.	Kingsford, Rev. B Maude, Hon. Cap., R.N.	Jackson, James	Thornycroft, J. Callendar, W.R., Jun.	Scholefield, B.	Turner, W. Robinson, J. B. Gilkes, Edgar		Taylor, Joshua Page, Wm.	Wild, John Murray, Geo. J.	Platt, T.	Shuttleworth, SirJ.K. Capel, Wm.
Where held.		British School	Lower Public School British Schools Boyal Polytochnic Institution	Sailors' Institute	Mechanics, Institute, St.	Modern Free School - Cathedral Schools -	Mechanics' Institute	68, Corporation Street Mechanics' Institute Mechanics' Institute	Mechanics' Institute Mechanics' Institute Mechanics' Institute	Iron and Alkan Works School Trinity House School Mechanics' Institute Mechanics' Institute	Analytical Literary Institute Parish Church School	Lyceum	Trades Hall Free School
Town		London—cont. Harp Alley, Far-	ringdon street. Islington Kingsland	Shadwell	Macclesfield -	Macclesfield Manchester	Manchester	Manchester Marsden Middlesbro	Netherton Newcastle-on-Tyne	Newcastle-on-1yne Newcastle-on-1yne Newton Heath Nottingham	Oldham Oldham	Oldham	Padiham Painswick

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_	King, Chs Milward, V	Noar, Wm.	Pickles, Joseph Hulbert, P. W.	Chanman J.	Newton, E. B	Hawke, E. H.	Boyns, R.	Welch, Rev. W.	Foster, IWm.	Taylor, Peter -	Weeks, C.	Mayne, J. O	Betts, Rev.J.	Irvine, Rev. A. C. Palmer, J.	Peace, M. W.	Langley, J. N	Meadley, J.	Keeble, W. D	Butcher, M.	SCOTLAND.		Hellas, Jas. F	Hourston, S.
	Hardman, R. H. Fessey, Rev. G. F.	Turner, W.	Dean, Wm. Hulbert, Rev. C. A.		Marsland. J.	Rogers, Rev. S.	Hadow, George	Hon. and Rev. W. H.	Dickenson, S	Page, James A.	Vivian, E.	Barham, C., M.D.	Hunt, C. B	Jesson, B Everett, J. G	Fergie, Rev. T. F.	Hes, Rev. J. H.	Russell, Rev. B. N	Anderson, John	Steward, R		Watson, Robt	Cargill, J., Capt. B.N.	Sturrock, Bev. G.
	unt School - snd Scientific In-	Stitute. Working Men's College	Mechanics' Institute Meeke and Walker's Educa-	tional Institute.	•	•	Mechanics' Institute		Lecture Room, King Street	National School	British School	Royal Institute	School House -	Grammar School Mutual Improvement So-	Rooms. and Mechanical	Working Men's College	Science and Art Institute .	Royal Arsenal-	Navigation School .		-	Navigation School	Girls' School
-	Rawtenstall	Salford -	Slaithwaite Slaithwaite	Sloneh .	Staleybridge	St. Day	St. Just	Stourbridge -	Strond	Tintwistle	Torquay	Truro	Upton, St. Leonard's	Walsall Wells	Wigan	Wolverhampton -	Wolverton -	Woolwich	Yarmouth, Great - Navigation School		Aberdeen	Aberdeen	Corsock

• Schools established in 1864.

List of Science Schools and Classes, &c.-continued.

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Secretary.		Cumming, A. W.	Cunliffe, B. S	Cunliffe, R. S	Martin, G.	Crawford, Robt.	Thomson, Rev.J. Bolam, James	IRELAND. Given, John Browne, Stephen,	Shepherd, W. Shepherd, W. Nesbitt, R.	Dowling, John . Withers, R.	Grey, P. J. Crory, W. G. Woodhouse, J McPadden, M Butter, Ed.	Shepherd, W.	Osborne, A. T	O'Neill, B.	West, Rev. J., D.D Hackett, Rev.J.W. Hoare, Rev. E. N Bardley, F. N	•
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Obsirman.		Sturrock, J.	Blackie, J., junr.			Aitken, Rev. James	Lindsay, W.	Rowen, Rev. R. V Doherty, R. W.	Lyttle, John - Lyttle, John - Patten, James	Patten, James Rogers, Rev. J.	Matthews. J. Manning, J. McCabe, Rev. E. McCabe, Rev. E.	Patterson, Robert,	F. Delib.	Durdin, Rev. J. G O'Neill, R.	West, Rev. J., D.D. Hoare, Rev. E. N.	
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Where held.		High School -	Secular School	Athenseum -	Andersonian University	New Public School	Navigation School -	District Model School Town Hall	Royal Academical Institute National Model School Navigation School	Model School Smyth's National School	Mechanics' Institute Athenseum Ohristan Schools Ohristan Brothers' School Central Model School	National Model School	National Model School	Endowed School	Training School Model School	
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Town.		Dundee -	Glasgow -	Glasgow -	Glasgowt	Kilmarnock	Leith -	Ballymena Bandon -	Belfast - Belfast - Belfast -	Carrickfergus Comber -	Drogheda Dublin - Dublin - Dublin -	Holywood	Newtownards	Oldcastle	Santry - Waterford	

TABLE showing the Subjects taught at each Science School, and also the Numbers in each School.

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	THE	Physical Geo- graphy.		<u>:::</u>	:::::::::::::::::::::::::::::::::::::::	::
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	XXI	Nautical Astro- nomy.		<u>:::</u>	:::::::::::::::::::::::::::::::::::::::	::
	XX	General Maviga- tion.		:::	:::::::::::::::::::::::::::::::::::::::	: :
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	XVIL	Systematic Bo- tany.		:::	:::::::::::::::::::::::::::::::::::::::	::
	XAI.	Vegetable Physi- ology and Eco- nomic Botany.		:::	:::::::::::::::::::::::::::::::::::::::	e:
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	x	Inorganic Che- mistry.		22:	1 : : : : : : : : : : : : : : : : : : :	88
	'XI	Magnetism and Electricity.	·	:::	:::2:::4: ::0:: : :::	$\overline{:}$
	AIII	Acoustics, Light, and Heat.	٥	:::	:::8:::9:::::	::
	IIA	Applied Mecha- nics.	NA.	:::	:::::::::::::::::::::::::::::::::::::::	::
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		Where held.		King James's School - Educational Institute British School Room	Mechanics' Institute - Cherwell Sechool The Laboratory, High St Midland Institute - Midland Institute - Working Men's Institute - Working Men's Institute - Working Men's Institute - Trade School - Trade School - Trade School - Church of England Lites Tristitute - St. Paul's School - Institute - St. Paul's School - Grammar School - Mechanics' Institute - Westgate School - Atheneum - Young Men's Christian Town Hall - Mechanics' Institute - Town Hall - Mechanics' Institute - Town Hall -	Educational Institute Mechanics' Institute
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Rooms of Society for Dif-fusion of Useful Knowledge
Duke of Bedford School Littlemoor Mechanics' Insti-Village Library and Reading Rooms National School Room Literary Society's Rooms Boys' School Working Men's Institute Trinity House Schools Christ Church Institute Working Men's College The Institute -Mechanics' Institute -Mechanics' Institute -Young Men's Institute National Schoolroom Mechanics' Institute Free Library . Town Hall . Where held. tute -Leeds Liverpool Loughborough Kidderminster Halifax Haslingden -Huddersfield ď Town. Eastington Exeter Gloucester Greenwich Gulworthy Dukinfleld Falmouth Glossop Glossop Hulme Kinver Exton

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(Signed) J. F. D. DONNELLY, Capt. R.E.

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Allen, Lonard Allen, William Allott, James Angell, John Arthey, William	Trinity House, Dundee Grammar School, Moulton, near Spalding National School, Manbon, North Walse Mechanics' Institute, Manchester Wilde's Endowed School, Lowestoft	:::::	;;;;;	;;;::	7:;::	;;::;	;;;::	::-*:	::-:	:0010	::0::	:::::	:::::	:::-::	:::::	:::::	:::::	::::		<u>-::::</u>	:::::	٠::::	
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	Address.	Model School, Waterford . 2, Upper Buckinghan Street, Dublin County School, Leiester . Training College, Westminster . Newport House, near Exeter	Waterford Trinity Schools, Ripon St. Mart's College, Chelsea 9, Victoria Street, Gowan, Glasgow 28, Halsey Street, Cadogan Terrace, S.W.	Charles School, Plymouth - Training College, Battersea Preparatory Schools, Greenwich - S. India Place, Edinburch Bolckow's Iron Works, Middlesboro'	St. Mark's College, Chelsea-Wesleyan Training College, Horseforry	Andersonian University, Glasgow 22, Brunswick Street, fuston Road Training College, Battersea	St. Mark's College, Chelses Walker Altali Works, Newcastle Baddow Road, Chelmsford
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XXIII.	Physical Geo-graphy.		:::::	es : :es :	::	:::	:01::4:

Table showing Certificates held by Science Teachers-continued.

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Grove, John W.	Green-coat School, Hertford 2, Radnor Terrace, Brownlow Rd., Dalston	:::	:::	:::	:::		:::		:::	** :		<u></u>	:::	:::	:::	; cq ·	:09						:::
Gunn, William . Haigh, Thomas B Hall, Henry B Haliday, John . Hancock, John .	Mechanics' Institute, Burnley Training College, Westminster Free Industria School, Birmingham Queenshead School, Halifax 17, Riding House Street, Laugham Place	* : : : :	:::::	:::::	:::::	:::::	::69::	:::::	~ ::::	od : : : :			:::::	69 : : : :	oa : : : :	oa : : : :	:::::	:::::	:::::	:::::	:::::	:::::	:::::
Handa, Jonathan G Harbison, Mann Hargreaves, John Hartley, Joseph Henessey, Ed. J.	St. Paul's School, Wilton Place Model School, Newtownards National School, Goldsboro' St. Bridgewater Street, Liverpool Boad, Manchester. Aberdeen Navigation School	:::::	;:::;	:::: :	:::: =	:::::	:::::	:::::	∞ ;⊢ ;	a :u::	e : 64 64 ·	: " : : : : : : : : : : : : : : : : : :	:::::	:::::	:::::	:::::	:::::	::::::	:::::	:::: -	:::: H	:::::	:::::
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Holmes, John Holt, George Honey, Robert Hogford, Frederick F	230, Holm Street, Glasgow Westminster Wesleyan Training College, Westminster Cowper's House School, Huntingdon 21, Pétorn Place, Carmarthen Sowerby, near Oakham	:::09:	:::::	:::::	:::::	:::::	:::::	:::::	:::::	:::::	: : : : : : : : : : : : : : : : : : : :	:::::	:::::	:::00	:::::	::::	:::::	:::::	:::::	:::::	69 : : : :	•• : : : :	:::::
Hough, Joseph Howard, John Hudson, Fearnide Hudson, Washington Hudson, J. Schoffeld	Wrottesley Observatory, near Wolverhampton. 1, Southgate Grove, De Beauvoir Town, N. GS, Corporation Street, Manchester Mechanics' Institute, Stockport National School, Brenkburn-morpeth	: ::**:	: ::-:	: ::63 :	: ::::	: ::::	: ::::	eo ::::	: 64 ::	: 00 ::	: : : : : :	: ::::	: ::::	: 07 :::	: 67 : : :	: •	: :07 : :	: ::::	: ::::	: ::::	: ::::	: ::::	: ::::
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	17, New Street, Charles Town, Halifax Cathedral School, Ripon 10, Henry Street, Chorlion-on-Medlock,	Olack Street, Kilmarnock Carrickfergus Sunderland St. Mark's College, Chelsen 9, Montague Place, Bast India Road,	London. Rathiff Street, Wolverton St. Mark's, Chelsea	Waterford Bridge Street, Frome Training College, Battersea 5, Havelook Terrace, Brooks Bar, Man chester.	St. Marks College, Chelsea St. Marks College, Chelsea S. Colleton Buildings, Exeter Newcastle-on-Tyne Grove Street, Huddersfield 17, Bloomsbury Square, London	Frampton Cotterill, Bristol 12, Westbourne Greve North, London 48, Over Street, Brighton Oneensland National School, Halifax 4, Marlbor Terrace, Victoria Boad, Ken- sington.	Privy Council Office, Whitehall National School, Cainecross, Strond British School, Torquay Wesleyan College, Westminster	Mechanics' Institution, Leeds Bridge Street, Bolton Training College, Batterses High Street, Slough The Grammar School, Deptford
_	Spencer, James Spink, John Spriggs, Christopher	Stevenson, James Stevenson, J. M.N. Shibes, James J. Scirrup, Phomas Stockton, William	Stone, William - Strachan, Richard - Strond, Robert	Sullivan Michael Swaine, James Tate, Ralph Taylor, Charles Taylor, Samuel	Thackrah, Samuel Thomas, James D. Thomas, James D. Thorn, Wm. H. Thidall, George Tilden, William A.	Tomkins, Samuel Tribe, Alfred Trower, Richard Turner, George Turner, Samuel C.	Twite, Charles - Vaughan, William - Vick, William - Viccars, Thomas - Waite, John -	Wakeford, Frank D. Ward, George Ward, Thomas Warner, William Watson, Joseph Watkins, James

Physical Geogra-:::: ;:::: ::::: :::: ::::: IIIXX · ::: Steam. :: : :: :: ::: :: :::: ::::: XXII nomy. ::::: ::::: :::: ::::: TXX Vautical Astro-Navigation. :::: : : : :: ::: :: : : : : : : ::: 'XX : : : :: : : : :: :: : :: : ::: :: ::: Metallurgy. XIX Mining : : : :: : : : : : : : : : : : : : : : : : : XAIII Vegetable Physio-logy and Econo-mic Botany. Systematic Bo-tany. ::::: ::: ; : :: : : : :07 : ::::: : XVII. :::: :: ::07 : ::: :: : : 09 ; ::: :: XAL : : :: : : : : : : : : : : : : : :: .VX Zooloogy. : logy. ::09 :01 : : : :: :03 : : : :: : : :: : = 'VIX -Рьувіо-**IsminA** Mineralogy. :: : : : : : : : :: : : : : : : : : : : : : : XIII 'IIX Geology. : :: :: : : : :: : : : :: : : : : : ::: Magnetism and Electricity. Inorganic Che-mistry. Organic Chemis-try. **⊣** Ø : :: :00 ಎಟಎ : : : : : : : :: ЛX. **⊣** თ ::• :01 : : : 07 09 pg :00 **___** :~~ :: x ::::: :00 ::: :-: :: ::: : 'XI Acoustics, and Heat. ::09 := :::: ::∞ : ::: :09: VIII. Applied nics. : : : : : :::::: ::::: :::: : :::: : IIA Theoretical chanics. : 2 : :: : : 93 : : :: : : : : : : : ·ΙΔ Hihger spitam ٠, ::::: ::: :: : :::: ٠ ::: ::::: thematies. ::: : : : ::::: ::::: : ::: ::::: .VI Elementary Building Con-struction & Naval Architecture. :::: ::::: ::03:: ::::: ::::: 'III Practical, Plane, and Descriptive Geometry.

Mechanical & Machine Drawing. ·II ::::: : ::-: : :: :: : :: : : : ::: ::::: T ::::: ::::::: : ::: inckley . 99. Cliffon Road Bast, St. John's Wood The Terrace Royal, Nottinghan Praining College, Westminster 77, Ash Grove, Bradford, Yorkshire 29. Queen Street, Edgehill, Liverpool Midland Institute, Birmingham -St., Mark's College, Chelsea Model School, Ballymena -Pennfields, Wolverhampton 17, Bloomsbury Square, London -Pennyman School, North Ormesby Wesleyan Day School, Newark 31, Richmond Place, Brighton The Grammar School, Bosworth, Hi t. Mark's, Chelsea t. Mark's College, Chelsea E. Mark's College, Chelsea t. Market Place, Manchester t. Mark's College, Chelsea Prestbury Road, Macclesfield National School; Middleton Address. Wire, Alfred P.
Wood, Charles H.
Wood, Edward Woodcook, Fred.W. Woodhead, William Woodward, Chas. J. Woollett, John Wren, Edmond
Yates, Frederick Williams, W. M.
Williamson, Stewart
Wilson, Thomas
Winney, William
Winter, William Watts, John
Weatherill, Robert
Webster, James H.
West, W. Fred.
Wheeler, George H. Whitehead. John E. Wild, Robert - Wild, William L. Willcock, Joseph Williams, John Name.

Table showing Certificates held by Science Teachers-continued.

SCIENCE AND ART DEPARTMENT OF THE COMMITTEE OF COUNCIL ON EDUCATION, South Kensington.

DIRECTORY,

(Revised to February 1866.)

13th EDITION.

WITH

REGULATIONS

FOR

ESTABLISHING AND CONDUCTING

SCIENCE SCHOOLS & CLASSES.

THE RULES IN THE PRESENT EDITION SUPERSEDE THOSE IN ALL FORMER EDITIONS, BUT ARE ALWAYS SUBJECT TO REVISION.



LONDON:

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1866.

Price Sixpence.

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COMMITTEE OF COUNCIL ON EDUCATION, CROMWELL ROAD, SOUTH KENSINGTON.

Lord President, The Right Hon. the Earl GRANVILLE, K.G. Vice-President of the Committee of Council on Education, The Right Hon. H. A. BRUCE, M.P.

LIST OF OFFICERS OF THE SCIENCE AND ART DEPARTMENT.

Office hours 10 till 4.

GENERAL ADMINISTRATION. Secretary.—Henry Cole, C.B.

Assistant Secretary.—Norman MacLeod. Chief Clerk.—E. Stanley Poole. First-class Clerks.—G. F. Duncombe, G. C. T. Bartley, S.* viii., ix., x., xii, xiv.; A. 2nd grade; Percival B. B. Peile, S. ix.; E P. Bartlett;

Second-class Clerks .- A. H. Gasparini; T. Hickson, A. 2nd grade; C. A. Pierce, A. 2nd grade; A. S. Cole, A. 2nd grade; A. J. R. Trendell. Provisional Clerks.—E. Belshaw, A. 2nd grade; W. Burtt, G. Millard, S. xxiii. Assistant Clerks.—W. H. F. Stratton, C. Comyns, C. G. Quinton.

Accountant .- A. L. Simkins.

Book-keeper.—H. W. Williams. Assistant.—T. A. Bowler. Storekeeper.—W. G. Groser. Deputy.—H. Lloyd.

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(Science) J. F. Iselin, M.A.; F. J. Sidney, LL.D. (Navigation) Captain

Harris, E.I.S. Professional Examiners for Science.—Prof. T. Bradley; Rev. B. M. Cowie, B.D.; Dr. Hofmann, F.R.S.; T. H. Huxley, F.R.S.; Dr. Kinkel, Ph. D., F.R.G.S.; J. Percy, M.D., F.R.S.; A. C. Ramsay, F.R.S.; W. W. Smyth, M.A., F.R.S.; T. Thomson, M.D., F.R.S.; J. Tyndall, F.R.S. Rev. Joseph Woolley, LL.D.

Organizing Master for Science Classes .- J. C. Buckmaster. ART DIVISION.

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Richard Redgrave, R.A. Occasional Examiner.—Rev. J. H. Edgar.

South Kensington Museum.

General Superintendent.—Henry Cole, C.B.

Deputy General Superintendent.—E. R. Festing, Captain R.E.

Director of New Buildings.—Lt.-Colonel Scott, R.E. Decorative Artist.—Godfrey Sykes.

Art Referees for the Museum.—R. Redgrave, R.A.; J. C. Robinson, F.S.A. Superintendents of Museum Collections .- R. A. Thompson; P. C. Owen; J. H. Pollen, M.A., late Fellow of Merton College, Oxford.

Division Keepers of Museum Collections .- G. Wallis; R. H. S. Smith, M.A., Trinity College, Dublin, F.S.A.; W. Matchwick; H. Sandham; R. Laskey.

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J. W. Appell, Ph. D.; A. C. King, F.S.A. Clerks of Collections.—D. Craven; J. B. Rundell.

Provisional Clerks.—H. Vernon; A. Masson; F. Coles, S. x. xi.; F. Groser, A. 2nd grade; W. G. Johnson.

Official Photographer. - C. Thurston Thompson. Hon. Surgeon. F. Seymour Haden, F.R.C.S.

ROYAL SCHOOL OF NAVAL ARCHITECTURE AND MARINE ENGINEERING. Inspector General and Director of Studies.—Rev. Joseph Woolley, LL.D. Principal.—C. W. Merrifield, F.R.S.

Vice Principal.—Henry Martyn Taylor, B.A., Scholar, Trinity College, Cambridge.

Instructor in Naval Drawing.—W. B. Baskcomb. Intructor in Engineering Drawing .- John Maxton.

Instructor in Practical Chemistry.—John Davidson.
Instructor in French.—M. Penon. * The letters S and A refer to the Science and Art Certificates taken.

Summary of the Nature and Amount of Assistance afforded by the Science and Art Department to the Industrial Classes in procuring Instruction in Science.

[Important Alterations made since the last edition of the Directory are printed in Italics.]

- I. A sum of money is voted annually by Parliament for scientific instruction in the United Kingdom.
- II. This sum is administered by the Science and Art Department.
- III. The head of the Education Department of which the Science and Art Department is a branch is the Lord President of the Council, assisted by a member of the Privy Council, who is called the Vice-President of the Committee on Education, and who acts under the direction of the Lord President, and for him in his absence. (Order in Council, 25th February 1856, Act 19 & 20 Vict. c. 116.)
- IV. The object of the grant is to promote instruction in Science especially among the industrial classes,* by affording a limited and partial aid or stimulus towards the founding and maintenance of Science schools and classes.†
- V. The payment of fees by the students can be looked upon as the only solid and sufficient basis on which a self-supporting system can be established and supported. Though my Lords do not consider it necessary at present to lay down any rules making the payment of fees an absolute condition of the grants on account of Science

^{*} Direct payments are made to teachers only on behalf of adult artisans, or the children of artisans, or the children of persons who are not assessed to the income tax, that is, who do not possess an income of 100l. a year. (See § xviii.)

[†] The amount is liable to be decreased and eventually withdrawn. Payments to teachers therefore must not be looked upon as perpetual, or in any way conferring on the teacher a claim to any payments beyond those offered for each current year.

instruction, yet as the payments from the State must be expected to diminish, and as aid on account of those persons who do nothing for themselves cannot be justified, Committees of schools and classes and Teachers are strongly urged (should it at present not be the practice) at once to impose as high a scale of fees as they consider can be raised not only on middle class students but also on artisans.

VI. The following are the Sciences towards instruction in which aid is given:—

Subject 1, Practical Plane and Descriptive Geometry.

2, Mechanical and Machine Drawing.

- ,, 3, Building Construction or Naval Architecture.
 - 4, Elementary Mathematics.
- ,, 5, Higher Mathematics.
- " 6, Theoretical Mechanics.

,, 7, Applied Mechanics.

- ,, 8, Acoustics, Light, and Heat. 9, Magnetism and Electricity.
- ,, 10, Inorganic Chemistry.
- ", 11, Organic Chemistry.
- ,, 12, Geology.

99

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,, 13, Mineralogy.

" 14, Animal Physiology.

" 15, Zoology.

" 16, Vegetable Physiology and Economic Botany.

, 17, Systematic Botany.

" 18, Mining.

" 19, Metallurgy. " 20, Navigation.

,, 21, Nautical Astronomy.

., 22, Steam.

" 23, Physical Geography.

VII. The assistance granted by the Science and Art Department is in the form of—

1. Payments on results to certificated teachers. (See § xv., xviii., and xix.)

2. Grants towards the purchase of apparatus, &c.

(See § xxi.)

3. Public examinations in which Queen's Medals, Honorary Certificates, and Prizes are awarded, held at all places complying with certain conditions. (See § xi., xii., xiii., xiv., xv., xvi., and xvii.) On the results of these examinations the payments are made to the teachers. (See § xv. and xviii.)

VIII. Examinations for certificates to Examinations teach any of the before-mentioned sciences Certificates. are held annually, commencing in the first week in November, at South Kensington. Examinations will also be held in Dublin, Edinburgh, and Manchester if five candidates register themselves for examination in Ireland and in Scotland and in the north of England. Any person whatever may attend this examination by sending in his or her name to the Secretary of the Science and Art Department, before the 15th October, stating the subject or subjects in which he or she wishes to be examined. Certificates of three grades are given in each subject. These certificates are only considered as simple records of the results of examination in the various sciences before mentioned, entitling the teacher to earn payments by successful teaching in the subjects for which he or she is certificated.* No payments can be made to a teacher on account of instruction in subjects in which he is not certificated.

IX. Suitable premises, with firing, light-mises.

ing, &c., must be found and maintained at the cost of the locality where the school or class is held. If at any time the funds do not cover these requisite local expenses, it must be inferred that there is no such demand as the Government is justified in aiding, for instruction in the locality; and the assistance of the Department will be withdrawn.

^{*} Such examination may be dispensed with in cases where the candidate has taken a degree, the examination for which satisfactorily meets the requirements of the case. Full particulars must be furnished by the applicant.

Local Committee of not less than five well known responsible persons must be formed in connexion with every Science Class, who will carry out the instructions contained in Appendix. (See pages 14 and 18 to 22.)

Examination XI. The Science and Art Departof Classes ment holds annually in May (see Science under Cer-Form, No. 232, page 59), through the agency of the Local Committees, a public examination of all Science schools and classes in any locality throughout the United Kingdom which complies with the requisite conditions. xiii., and xiv.) On the results of this examination the payments are made to certificated teachers. (See § xv. and xviii.) Application for it must be made before the end of March in each year, stating the number of persons and the subject or subjects in which they are to be examined. The form of application, Science Form No. 119 (see page 22), will be sent on application to the Secretary, Science and Art Department.

In addition to the above, examinations in mathematics, navigation, nautical astronomy, steam, and physical geography are held for the benefit of seafaring men, and for them only, three times a year in all seaports where Local Committees are formed and are willing to undertake them. These examinations take place in the beginning of March, September, and December. The application for these examinations must be made on Science Form No. 119 before the 10th day of the previous month.

Examination of other a teacher not holding a certificate, may, by applying to the Secretary of the Science and Art Department, be examined at the same time and in the same manner as the classes under certificated teachers: provided that a Local Committee be formed which complies with the requisite conditions. (See Appendix, page 21, Science Form, No. 88 a.)

If the class be for artisans the pupils are eligible to receive Queen's Prizes and Queen's Medals under the same condition as the pupils of certificated teachers. Should it however be for the middle classes the pupils are not eligible for prizes and medals, but receive certificates of merit instead.

XIII. If two or more classes in the same Places of town, or within a reasonable distance of one another, apply for the examination of the Science and Art Department, a general examination committee must be formed by the amalgamation of the several Committees to carry out the examinations at some common centre, such as the town hall or other public building. It is only when the classes consist of 100 or more candidates that such amalgamation of the committees will not at present be insisted on.

XIV. Any persons whatever, whether taught by the certificated teacher or not, students. may present themselves at the Local Committee's examination on registering their names in time for the Local Committee to comply with the instructions, and paying a registration fee of not more than 2s. 6d. each. Arrangements must therefore be made by the Local Committee, or the General Examination Committee, as the case may be, to enable other candidates, besides the students in the class for which the Committee act, to present themselves at this examination. The registration fee of 2s. 6d., which such candidates may be required to pay, is to reimburse the Committee for any extra expenses incurred by such attendance, and may at their option be remitted.

XV. The successful candidates at the Classification of Results.

May examination and the quarterly examinations of seamen are classified under the heads of first, second, third, fourth, and fifth class. The standard of attainment required may be raised from year to year. For the fifth class it is only such as will justify the Examiner in reporting that the instruction has been sound, and that the students have benefited

by it. Those who have attained a higher degree of proficiency are classed as 4th, 3rd, 2nd, or 1st class, according to their merit.

Queen's AVI. To the 1st, 2nd, and 3rd class are given Queen's prizes consisting of books or instruments chosen by the candidates from lists furnished for that purpose. These are unlimited in number, and are open to all candidates who come within either of the following categories, except as below, see a. and b. (1) Students in Science Classes under Certificated Teachers; (2) Registered Students in Artisan Classes taught by Non-certificated Teachers, or (3) bonà fide artisans.

Other candidates, if successful, receive instead Cer-

tificates of merit recording their success.

The following are exceptions to the above rule.

· a. Science Certificated Teachers; and

b. Students who have previously received the same, or a higher class prize, in the same subject.

The names of such candidates will simply be re-

corded in the published lists.

Queen's Medals. XVII. To the four best in each subject are awarded Queen's medals. These consist of one gold, one silver, and two bronze in each subject for competition throughout the United Kingdom. They are only awarded if there are a sufficient number of qualified candidates, and the gold medal will only be given in cases of high merit specially recommended by the examiner. The same candidate cannot obtain the same medal in the same subject more than once.

Only registered students of schools and classes under Local Committees (see § x. and xii.) are eligible for medals. They cannot be taken by middle class students who are more than 17 years of age. Students who but for this restriction would have taken the medal, will receive an honorary certificate instead. Should a student take more than one gold, silver, or bronze medal, he will receive books instead of a second medal.

XVIII. Payments are made to the Payments to certificated teacher on account of the instruction of students of the Artisan Classes (for definition of Artisan Class see Science Form No. 51, page 24) in the following manner:—

11., 21., 31., 41., 51. are the claimable payments for each student in each subject, according to the class in which he passes, but these amounts may be reduced

in the following ways:

1st. If the student has been successful in the same subject before such payments are reduced by the normal payment which was claimable on such previous success; for instance, the 4l. payment for a second class would, if the student had previously taken a fourth class, be reduced by 2l.*

2nd. If a student be successful in more than one subject at an examination, the payments on account of such further subjects are reduced by one half.

3rd. When on this scale they would amount to more than 60l. the excess up to 40l. is diminished by one quarter, the excess above 40l. by one half. Thus payments which on the above scale would be 100l. and 150l. will be reduced to 90l. and 115l. respectively: †—provided that the student has received 25 lessons ‡ at least from the teacher in each subject in which he claims payment since the last examination, each lesson being an attendance at a meeting of the school of at least three-quarters of an hour's duration on a separate evening. The 25 lessons need not neces-

† Thus, 100, that is 60+40, is reduced to $60+40-\frac{1}{2}$ of 40 = 60+30=90. 150, that is, 60+40+50 is reduced to 60+30+25=115.

^{*} Deductions will be made in payments on account of Subject I. to the amount of any payments that have been made on Second Grade Examinations in Art, in practical geometry, perspective or mechanical drawing.

[‡] It must be clearly understood that the number (25) of lessons which the teacher is required to give is the minimum fixed as a criterion that the pupil has received his instruction from the teacher. It is not meant in any way to specify that that amount of instruction is sufficient, or to guarantee the teacher's receiving payment, if that amount of instruction alone is given.

sarily be all given in one year, but may extend over a longer period.

Form of Claim and the several heads is made on Science Form No. 51, which will be sent on application. The voucher must be signed by the secretary and two members of the committee of the science class or school; or by at least three of the committee. (See Appendix, page 24.)

School Register. XX. A school register must be kept in each subject on a form which will be supplied on application. This must be made up from day to day, and will be examined and approved by the Inspector on his visit. It must be sent to the Department with the teacher's claim for payment, and no payment can be made unless it is properly kept.

Grants for Apparatus. XXI. A grant towards the purchase of apparatus, diagrams, &c., of 50 per cent. on the cost of them, is made to science schools and classes in Mechanics' and similar institutions where the teacher is certificated, and to the extent of 5l. to other poor schools and classes. A requisition must in these cases be made on Science Form, No. 49. (See page 30.)

Travelling Expenses of Teachers.

XXII. The travelling expenses (second-class railway fare, and 10s. per diem personal allowance) of a candidate in attending the November examination are paid if he be successful in taking a certificate or in improving the grade of one he has already taken, provided the candidate is bonâ fide engaged in tuition, or is preparing for tuition.

Instruction in an Elementary School.

XXIII. All payments to certificated teachers on account of Science teaching are made by the Science and Art Department, and are only made in respect of a school in connexion with the Science and Art Department. They do not apply to any instruction

in Science that may be given during the three attendances of an Elementary School receiving aid from the Education Department, Whitehall.

XXIV. These grants are only made Use of Elementary while the teacher is giving instruction School in a day or evening school or class Premises. for the industrial classes (adults or boys), approved by the Science and Art Department, and open at any time to the visit and inspection of its officers. The Managers of an Elementary School under the inspection of the Education Department can permit such part or parts of their premises to be used for Science teaching as shall not interfere in any way with the three attendances of the Elementary School.

N.B.—On the next page will be found a table of memoranda for the use of Secretaries and Members of Science Committees (Science Form, No. 170) which it is expected will be carefully attended to. This, as well as the other forms given in the Directory, can be had on application to the Secretary, Science and Art Department.

APPENDIX.

SCIENCE FORM, No. 170.

MEMORANDA FOR THE USE OF SECRETARIES AND MEMBERS OF SCIENCE COMMITTEES.

Dates.

Before 30th November.

Constantly -

Before 1st January

Before 31st March

Before 24th April -

On the 27th April

During the May examinations.

On the evening of examination.

After the May examinations.

Formation of Committee, Form No. 88. Or continuation of Committee, Form No. 168.

To visit the School and see that the Register is kept from day to day, and that everything is regular.

To carefully fill in and send to the Department Form No. 120.

To send Form No. 119 applying for examination in May.

To see that Form No. 91 is hung up in the Schoolroom.

If a parcel containing (1) the papers for the candidates to work upon, (2) copies of Form No. 91, one for each day's examination, and (3) envelopes in which to return the worked papers, should not have been received, or if there should be any mistake in the numbers sent for each subject as applied for, or in the covering letter, to communicate at once to the Department.

The examination papers for each evening will leave London by the night mail two evenings before, i.e., Thursday evening papers will leave on Tuesday evening, Friday's on Wednesday evening, etc. Should they not arrive accordingly, a telegram to be sent at once to the Department.

The candidates, being all seated at 6.50, to read out the rules on Form No. 91, then give out the papers to be worked on. Then at 6.55 to break the seal of the examination papers and distribute to the candidates. To adhere rigidly to the rules on Form No. 91. To sign Form No. 91. To seal up the papers in one of the envelopes provided and at once post them.

On receiving lists of the results to give one copy to each candidate whose name appears in it as being successful; to inform the others they have failed

To return Form No. 161 filled up as soon as possible in strict accordance with the rules on Form No. 110. (Prize List). To return Form No. 123. To examine and certify Teacher's claims for payment, Form No. 51, and the School Register, which must be sent up at the same time. To return Form No. 108.

To keep a record of, and inform the Department of the number of individuals examined.

EXHIBITIONS AND FREE ADMISSIONS AT THE ROYAL SCHOOL OF MINES, LONDON.

ROYAL EXHIBITIONS.

1. There are eight Royal Exhibitions to the Royal School of Mines, Jermyn Street, of the value of 50l. per annum, entitling the holders to free admissions to all the lectures, and to the Chemical and Metallurgical Laboratories at the Royal School of Mines, to be held from year to year for three years, on the condition that the holder attends the lectures regularly during those years, and passes the examinations required for the associateship of the School.

At the May 1866 examination two of the above Royal Exhibitions will be open for competition independently of the prizes, &c. offered by the Science and Art Department.

All persons over 21 years of age, excepting artisans, and such as come within the category of persons paid upon under the Science Directory, will be excluded from competing for the Royal Exhibitions. Special cases, however, must be determined according to the spirit of the rules, and the object of the endowment.

The competition for the Royal Exhibitions will be determined by affixing the following values to the several results of the May examination (see Science Directory), viz.:—

	To a 1st grade Queen	's Prize	in a	y aubjec	t -	- 9 r	narks.
	To a 2nd "			**	-	- 7	39
	To a 3rd "	"		**	-	- 5	39
	Toa4th "-	•	•	39	-	- 8	29
	To a 5th "	•,	•	**	•	, - 1	**
and in	addition—						
	For a gold medal	- "			_	10	
	For a silver medal		-	99	-	•	•
	· ·	• .	-	30	•	- 7	*
F "	For a bronze medal	•	-	99	-	- 5	*

N.B.—Science Certificated Teachers may compete for the Royal Exhibitions. When coming up simply with this object, they should inform the Science and Art Department, so that their names may not appear in the published list with the students.

FREE ADMISSIONS.

2. Free admissions to the lectures at the Royal School of Mines, Jermyn Street, are granted to any person who takes a gold medal in the May examination.

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ROYAL EXHIBITIONS

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Antitions will be determined by several results of the May Examina-

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.+ Agen, Brhibitions. Wass ---mon and Art Department ---- the students

School of Science, Dublin. The following candidates at the recent May Examinations are cand
dates for the Royal Exhibitions at the*
and they are either—
1. Under 21 years of age.
 Or artisans or operatives in the receipt of weekly wages, supporting themselves by their own manual labour, or their children nearning their own livelihood.
 Or, although not artisans, yet such as may fairly be considered belonging to the industrial classes. as coming within one of t following categories, or being the children of such.
a. Though paid at longer intervals than a week, still supporting himself by his own manual labour and not by profit on the labour of others, that is, not employing apprentices, journeymen, etc.
b. Though not supporting himself by manual labour, yet being of the same means and social level as those who do so, (such shopkeepers who have only petty stocks and employ no one be members of their own family,) policemen, coastguards, etc.
c. Though not supporting himself by manual labour, yet su as it would be unreasonable to expect to pay the fee of midd class students, as some descriptions of clerks, shopmen, etc., a we certify that they or—in case they are not earning their ov livelihood—their fathers are not assessed to the income tax.
4. That they are entitled to be considered as a special case on t following grounds:—
We hereby certify that the above particulars are correct. Chairman or Secretary
Two members of Committee.
* After each name must be stated all the successes of the candidate at a May Examinations and the category under which he claims.
† Should the candidate not have been a student in any Science School Class under a regular constituted Committee, this voucher must be certifiby three householders whose occupation and address must be given in full.

SCIENCE FORM, No. 88.

LOCAL COMMITTEES FOR SCIENCE SCHOOLS AND CLASSES.

- 1. A Local Committee of not less than five well-known responsible persons must be formed in connexion with every Science class, in order to comply with the necessary requirements of the Science and Art Department, and to carry out various arrangements on its behalf necessary for testing the efficiency of the science instruction, on the proof of which alone the aid of the Department is given.
- 2. The gentlemen proposed to act on this Committee are to fill in the form on the next page, stating their willingness to carry out the necessary arrangements for examinations, &c., and giving the address and occupation of each member.
- The relation of the Committee to the teacher of a Science school or class will vary much according to the varying circumstances of different localities. In some places where the demand for science instruction is great, and there is an energetic local teacher to take advantage of it, the chief duty of the Local Committee may be to give the teacher the necessary vouchers for obtaining his payments. While in other places, where those who take an interest in and wish to further science instruction may, with that object, subscribe to and establish scientific classes either in connexion with an existing institution or not, and may engage a teacher certificated in science to instruct the classes, the teacher must, to a great extent, be the paid officer of the Committee. With these local arrangements the Science and Art Department does not interfere, but leaves them to the locality to settle. The local circumstances will determine whether, as in the first case, the master receiving the whole of the fees for instruction should provide at his risk the room for instruction, with the necessary firing, lighting, &c., or what, as in the second case, should be the proportion of the fees deducted on this account by the Committee.
- 4. The Science and Art Department requires that the Local Committee shall
 - a. Be responsible for the safe custody of all apparatus towards the purchase of which the Department has paid 50 per cent.
 - b. That they shall provide a room or rooms of sufficient size to carry out the annual examination according to the detailed regulations under that head. This examination is of all persons who wish to present themselves, and not only of those taught by the certificated teacher; but those persons who are not taught by the certificated teacher must send in their names before the 1st March, and may be required to pay a registration fee of 2s. 6d. for the whole examination.
 - c. That a school register, showing the attendance, number of lessons, payment of fees, &c., on an approved form, be kept properly filled up, and sent to the Science and Art Department when required.
 - d. That they shall send in to the Secretary of the Science and Art Department the list of students to be examined, before the end of March, specifying the subjects in which they are to be examined. That they shall be responsible for conducting and superintending the examination: giving out the examination papers which will be

- sent for that purpose: seeing them worked fairly and certifying to the same, not less than three of the Committee being always present: and sending the worked papers, under seal, by the day's post to the Secretary of the Science and Art Department.
- e. That they shall certify, firstly, that those students on whose examination the teacher bases his claim to payments on results, are artizans or operatives, or their children, or can claim as such (see Science Form, No. 51); and, secondly, that they have received 25 lessons at least from the teacher in the year or since the last examination, on their passing at which payment was claimed on their account.
- 5. The Science school or class must be at all times open to the visit and inspection of the officers of the Science and Art Department as a condition to the grant of aid from it; if at any time it is found that the apparatus, &c., towards the purchase of which a grant has been made is not properly taken care of, or that a proper room with firing, lighting, &c., is not provided for the class, the aid of the Department will be withdrawn.

Note.—As it is to the Committee that the Department looks to carry out the great proportion of the duties of the school, as many as possible of the members of the Committee should attend on the inspector's visit.

Form of Application to act as a Committee for a Science School of Class.

We the undersigned.

[f. The Committee shall be composed entirely of well-known responsible persons of position who are quite independent of the school or class, and who have no or position who are quite independent of the school or class, and who have no such personal interest in it as can lay them open to the slightest suspicion of partiality; and of course no member should be connected with the Teacher, have any pupils for examination, or be a pupil himself.

g. It is very desirable that as many persons as possible in recognized positions of public responsibility in the district, such as Magistrates, Municipal Authorities (Mayor, Aldermen, or Town Councillors), Head of Educational Establishments (Trustees of Grammar Schools, Managers of National Schools), Clergymen, &c., should be on the Committee.

h. It is absolutely necessary that at least two such responsible persons should agree to act.

agree to act.

i. The Committee must consist of a Chairman, Secretary, and at least three other

Members. The Chairman must be a Magistrate, Mayor, Boroughreeve, Provost, or Alderman, or other public officer of recognized position, Trustee of Grammar School, or Clergyman of the Established Church in parochial employment.
 The Chairman of the Committee will inform My Lords as to the constitution of

The Chairman of the Committee will inform My Lords as to the constitution of the Committee being in accordance with these requirements.
 The Secretary of the Committee of the Science School or Class, as being the medium of communication, will carry on all correspondence with the Science and Art Department, and is held responsible for making out and sending all returns required, for the receipt and distribution of the examination papers, the transmission of the worked papers, &c., at the proper times according to the regulations; and in consequence of the necessary demands on his time and trouble My Lords have sanctioned, provisionally, the payment to him of the following fees:—I. annually for furnishing the returns, &c. specified on Science Form, No. 170, connected with any Science school or class, and 1k in addition for each day's examination held by the Committee to which he is Secretary. The Secretary must be a member of the Committee; the requirements in par. 1 apply equally to him.
 This form is to be filled in and returned to the Department annually before the 15th December, except in the case of new schools or classes, when it should be made as soon as they are formed.]

propose to act as the Local Committee for the Science Class held at

We undertake for the year at least, and further till another Committee satisfactory to the Science and Art Department has been appointed,

- To be responsible for the safe custody of all the Apparatus, Diagrams, &c., towards the purchase of which the Department has in any way contributed.
- 2. That three or more of our number will be ready at the appointed time to be present at, and superintend, the examinations of the Science Class according to the instructions of the Science and Art Department, and give the teacher the necessary vouchers.
- 3. That a room or rooms shall be provided for the due carrying out of such examination, according to the rules of the Department, providing sufficient space for the examination, not only of all persons taught by the certificated teacher, but of all others who may wish to attend the examination.
 - (A fee of not more than 2s. 6d. may be charged on each applicant for examination who is not a student in the class, to reimburse the Committee in any extra expenses they may be put to in providing a room).
- 4. That the School or Class shall be open at any time to the visit and inspection of the Officers of the Science and Art Department.

SIGNATURE.	Address.	Occupation, specially stating how fulfilling the conditions of "g." and "k." above.
Chairman.		
Secretary.		

I certify that this Committee complies with the requirements of the rules 1, 2, 3, 4, and 5.

Chairman.

The Secretary,

Science and Art Department.

This form may be had on application to the Secretary, Science and Art Department, South Kensington.

SCIENCE FORM, No. 168.

Where the same Committee proposes to act again it will not be necessary to resign the above, No. 88, but only to hold a meeting and fill up this form, No. 168, which may be had on application.

SCIENCE FORM, No. 88 a.

LOCAL COMMITTEES FOR SCIENCE SCHOOLS AND CLASSES NOT RECEIVING AID FROM BUT EXAMINED BY THE SCIENCE AND ART DEPARTMENT.

This Form is a modification of the previous, No. 88., and may be had on application to the Secretary, Science and Art Department, South Kensington.

SCIENCE FORM, No. 120.

SCIENCE CLASSES UNDER CERTIFICATED TEACHERS.

(If a student attends two or more classes he must only be counted as one student.)

CLASSES IN (state subject).	Fees.	No. of Students.	Days on which they meet.	Hours of Meeting.	Period of the Year during which the Classes continue.
,					

NAMES OF SECRETARY AND MEMBERS OF THE COMMITTEE.

(The undertaking on Science Form, No. 88, is for the year at least, and further till another Committee satisfactory to the Science and Art Department has been appointed. This Form, No. 88, must therefore be filled in and sent to the Department annually when the class recommences, except in those cases in which the whole of the Committee, wishing to continue, formally authorize the Chairman and Secretary to report to that effect. It will then only be necessary for new members to sign the form undertaking to perform the various duties.)



SCIENCE FORM, No. 119.

APPLICATION FROM

SCIENCE SCHOOL FOR EXAMINATION IN MAY.

To be sent to the Secretary of the Science and Art Department before the end of March.

	.iiixx	Physical Geo- graphy.	
١	.IIXX	Steam.	
	.IXX	Nautical Astro- nomy.	
	.xx	General Mariga- noit	
	XIX.	Metallurgy.	
	XVIII.	Mining.	
	TIAX	Systematic Bo- tany.	
	.IVX	Vegetable Physi- ology and Eco- nomic Botany.	
	.vx	Zoology.	
	.VIX	Animal Physi-	
	TIIX.	Mineralogy.	
	XII.	Geology.	
	.IX	Organic Chemis- try.	
	.х	Inorganic Che- inistry.	
,	'XI	Magnetiam and Electricity.	
	.IIIV	Acoustics, Light, and Heat,	
	·IIV	Applied Mecha-	
	.IV	Theoretical Me- chanics.	
	Λ.	Higher Mathe- natics.	
•	.VI	Elementary Ma- thematics.	
	.III	Building Con- struction,	
	.II	Mechanical and Machine Draw- ing.	
	·1	Practical, Plane, and Descriptive Geometry.	
			umber of students under in- struction during the year 'umber intending to present themselves for examination themselves for examination themselves for examination not belonging to the class

Total number of students * intending to present themselves for examination... Total number of students * under instruction during the year.

Name and address of the person to whom the examination papers are to be sent.

Specify here the arrangements which have been made in accordance with § XIII. of the Science Directory to conduct the examination of N.B.—The address must be that to which the Examination papers are to be sent. any other classes in the town (if there be any) at the same centre.

* The total number of swateridwal students only should be here given, so that if one student attends two or more classes he must only be counted as one.

FORM No. 363.

The following form, which may be had on application to the Secretary, Science and Art Department, is filled up in italics as an example of the manner in which it should be done.

An Account of Travelling and Personal Expenses disbursed and Charged by

Thomas Jones.

From the 2nd November 1860, to the 4th November 1860.

I hereby certify that the travelling expenses detailed below have been actually disbursed by me in travelling in the execution of my public duties, that the personal expenses are charged according to the regulations, and that the total sum of £1 13s. 8d. is due to me for the services stated.

Thomas Jones.

[Name and title of officer to be specified.]

Teacher of Chemistry in———School of Brighton.

1860. To attend examination in Chemist South Kensington on 3rd November. Sand November (sand Class) Srd November. South Kensington on Brighton t (sand Class) Omnibus fare to and from Charing South Kensington	6 r 18	hel	d at						
srd November. Omnibus fare to and from Charing	0								
	Cra			-	6	-			
South Kensington 4th November. Railway fare from London to Bri	ghto	m-	:	0	6	6		18	۵
s days' personal allowance at 10s.	-	•	•		-	-	1	õ	ö
							1	13	8

Nors.—Should the successful candidate live in London, Edingurgh, &c. or near enough to get home at night, he is only to be allowed 8s. per diem besides his travelling expenses.

Examined and approved,

Received this ______day of ______18 , the sum of ______pounds _____shillings and ______pence, in payment of the above amount.

SCIENCE FORM No. 51.

SCIENCE AND ART DEPARTMENT OF THE COMMITTEE OF COUNCIL ON EDUCATION, SOUTH KENSINGTON.

Application from_

_____Science Teacher in

			 				
On be : certify		Com	mittee of Man	agemen	t of th	is School, We do	hereby
	• •	pon h	im as a Science	e Teac	her in	formed the variou the School, dur 186 .	s duties
ť	That he has he year, or	give since	n the following the last exam	Stude ination	nts at at whice	least 25 lessons ch payment was yment is claimed.	claimed
,	eceipt of t	veekl		rting t	hemselve	ns or operatives' es by their own ivelihood.	
						} b	o mem- ers of
I here	eby certify	that t	the following pa	articula	rs are c	orrect.	amittee.
N.B.—Th der in t dec			PASSED ARTIZA students must b placed his sever he amount claim			E STUDENTS.* abetically. After end has more than or ess after making the	each stu- ne); and ne proper
N.B.—The der in to dec	te names of tt's name mu the last colu- luctions.	the sust be mn t		e arrangal successed on ea		abetically. After ene has more than or ess after making the Highest Position in same Subject	Pay- ment
dec	ne names of it's name muthe last colu- luctions.		students must b placed his sever he amount claim Trade, or father's trade.	e arrangal successed on est	ged alph sses (if l sch succe ion at late	abetically. After enter that of the sess after making the Highest Position	Pay-
dec	te names of tt's name mu the last colu- luctions.	the sust be mn t	students must b placed his sever he amount claim Trade, or father's trade. (State which	e arrangal successed on est	ged alph sses (if I ach succe ion at late ination.	abetically. After ene has more than or ess after making the Highest Position in same Subject	Pay- ment
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dec	te names of tt's name mu the last colu- luctions.	the sust be mn t	students must b placed his sever he amount claim Trade, or father's trade. (State which	e arrangal successed on est	ged alph sses (if I ach succe ion at late ination.	abetically. After ene has more than or ess after making the Highest Position in same Subject	Pay- ment

Should the Teacher have instructed any Students who may fairly be considered to belong to the industrial classes, but whose wages are paid at longer intervals than a week, or who do not support themselves by their own manual labour, the claims on their account must be made by the Committee of the school on the form on page 3, when they will be considered on their merits.

Secretary. Two members of Committee. Teacher.	to recomme claim the a be taken as be taken as following of a. Thou, his is n b. Thou, mea have farm c. Though the some we certify (1). The in e (2). This fath (3). The	end that the control of the control	to t	eacher, Mr. — e following str. he industrial cong the childrener intervals the course and not by prentices, journag himself by novel as those works and employ coast-guards, lag himself by expect to pay folerks, shopm on them (25) lesson at which pawhich payment ased to the incomparticulars of the particulars of the set of the particulars of the set o	idents, velasses, an of suce an a week y profit neymen nanual ho do sy no on &c. manual the fee een, &c. ons at le yment velasses is claim to tearnin me tax.	whom was coming the company of the c	be allow- ce consider may ing within one of supporting himse labour of others, yet being of the as shopkeepers nembers of their yet such as it wildle class studenting the year, or med on their accown livelihood— Teacher grounds	ed to fairly f the elf by that same (who own vould ts, as since ount, -their
Ders of Committee. Teacher.	-PP						Secretar Secretar	χ.
Teacher. Names of Passed Students must be arranged alphabetically. After each student's name must be placed his several successes (if he has more than one); and in the last column the amount claimed on each success with the proper deductions. Under the names of students in category "c" a line must be drawn. Surname. Christian Name in full. Trade, or father's trade. (State which is given). Subject. Grade. Grade. Grade. Christian Christian Christian Christian Subject. Grade. Christian Name in full. Subject. Grade. Christian Christian								_
NAMES OF PASSED STUDENTS CLAIMING AS INDUSTRIAL CLASSES. N.B.—The names of the students must be arranged alphabetically. After each student's name must be placed his several surcesses (if he has more than one); and in the last column the amount claimed on each success with the proper deductions. Under the names of students in category "c" a line must be drawn. Christian								
NAMES OF PASSED STUDENTS CLAIMING AS INDUSTRIAL CLASSES. N.B.—The names of the students must be arranged alphabetically. After each student's name must be placed his several surcesses (if he has more than one); and in the last column the amount claimed on each success with the proper deductions. Under the names of students in category "c" a line must be drawn. Christian	I hereby	certify tha	t the	following part	iculars	are com	·	
&c. The Secretary, Science and Art Department. (The following particulars will be filled up at South Kensington.) Examined and found correct to the extent of	N.B.—The name column	ames of the must be place in the amount ander the nan Christian Name in	stude ed his et clai	nts must be arra several successe med on each suc students in categ Trade, or father's trade.	nged alp s (if he h cess with ory "c" Posit the	habetica as more to hathe pro a line n ion at late	lly. After each stuchan one); and in the per deductions. **sust be drawn.** Highest Position in same subject	Pay- ment
&c. The Secretary, Science and Art Department. (The following particulars will be filled up at South Kensington.) Examined and found correct to the extent of		full.		is given).	Subject. Grade.		Examination.	ciaimea.
&c. The Secretary, Science and Art Department. (The following particulars will be filled up at South Kensington.) Examined and found correct to the extent of								
&c. The Secretary, Science and Art Department. (The following particulars will be filled up at South Kensington.) Examined and found correct to the extent of			-					
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Science and Art Department. (The following particulars will be filled up at South Kensington.) Examined and found correct to the extent of	& c.							
Examined and found correct to the extent of			Depa	artment.	!	1	1	1
						at Sou	th Kensington.)	
Approved day of					day			

[SPECIMEN.]

Science Form, No. 51. South Kensington, July 1865.

SCIENCE AND ART DEPARTMENT OF THE COMMITTEE OF COUNCIL ON EDUCATION. SOUTH KENSINGTON.

Application from John Smith, Science Teacher in the Science School or Institution at Midhurst for payment.

On behalf of the Committee of Management of this School, We do hereby certify:—

(1.) That Mr. J. Smith has duly performed the various duties devolving upon him as a Science Teacher in the School, during the year ending 31st day of May 1865;

(2.) That he has given the following Students at least 25 lessons during the year, or since the last examination at which payment was claimed on their account, in each subject for which payment is claimed:

(3.) That the undermentioned students are artizans or operatives * in the receipt of weekly wages, supporting themselves by their own manual labour; or their children not earning their own livelihood.

Wm. Brown, Secretary.

John Jones, Two members of Committee.

I hereby certify that the following particulars are correct.

John Smith, Teacher.

Names of Passed Artizan or Operative Students.*

N.B.—The names of the students must be arranged alphabetically. After each student's name must be placed his several successes (if he has more than one); and in the last column the amount claimed on each success after making the proper deduction.

Surname.	Christian Name in full.	Age last Birthday.	Trade, or father's trade. (State which is given).	Position the last Examination Subject.	ate ation.	Highest Position in same Subject at any previous Examination.	Payment claimed.
Adams, " Barber, Smith,	James, "," John Wm. Henry. William,	22 " 14 12	Carpenter, " Butcher (f) Baker (f)	X. XI. XIV. X.	1st 2nd Pass 1st 4th 1st	4th 2nd 	£ s. 5 0 1 0 0 10 0 10 2 0 5 0

^{*} Should the Teacher have instructed any Students who may fairly be considered to belong to the industrial classes, but whose wages are paid at longer intervals than a week, or who do not support themselves by their own manual labour the claims on their account must be made by the Committee of the school on the form on page 3 when they will be considered on their merits.

SCIENCE FORM, No. 108.

Application from	ce School or Class at	Secretary of the Local
	e for duties connected	with the School, and for
Science "Directory,*" j	for duties connected w and for superin	o the regulations of the nith the Science Class at tending the arrangements
for carrying out the exam	inations on	the following days
in May 186, I request	that the sum of £	may
be paid to me, being the ar	uthorized fee.	
Dates of Examination.	Dates of Examination.	Dates of Examination.
	-	
	I am, Sir,	
	Your	obedient Servant,
The Secretary,		,
Science and Art Dep	artment.	
	·	
&c. may be obta (taught by a T	LINED BY SCIENCE	Instruments, Books, Schools or Classes red in Science),† in utions, &c.
under their consideratio masters of Mechanics' a them of Apparatus and I Art Department for teach	n several applications, nd other Institutions, Illustrations, recommen ning science, think it hall regulate the decisi	on Education, having had from the managers and for grants to be made to added by the Science and necessary to adopt some ons of the Committee in

^{* £1} annually for furnishing the returns, £c. specified on Science Form No. 170, connected with any Science school or class, and £1 in addition for each day's examination held by the Committee to which he acts as Secretary.

† Apparatus not exceeding 10L in value may be obtained by poor Schools and Mechanics' Institutes, not taught by a certificated teacher, under the same conditions, that is, the Department will aid them to the extent of 5L.

Their Lordships have already fully recognized the great importance of practical science to all classes of the community, in all relations of life. They are, therefore, desirous that the Science and Art Department should assist, as far as possible, in promoting the distribution of diagrams and apparatus as the means of accomplishing this object; but as the indiscriminate gift of these aids for instruction to all applicants might lead to abuse, it is necessary to require some guarantee that they will be duly appreciated, which the mere request to have them does not imply.

The principle which governs the whole proceedings of the Department in all its branches is to afford partial aid, and to encourage, but not supersede public exertions in promoting education in science. They have, therefore, resolved that the Department shall have the power to assist schools and classes taught by a certificated teacher in Mechanics' and other institutions in purchasing diagrams and apparatus for teaching science at a reduction of 50 per cent. on the net cost.

Lists of the scientific diagrams and apparatus prepared by the Department, according to conditions of the following Minute, may be obtained of the Secretary of the Science and Art Department, South Kensington, London, W. It should be distinctly understood that the aid of the Department in purchasing these articles at a reduced price, if above 10*l*. in value, can be granted only to public schools and institutions when taught by a certificated teacher.

Minute of the 23rd March 1860.

"The Lords of the Committee of Council on Education desire to afford the greatest facilities to teachers of science and navigation schools in obtaining the best instruments, apparatus, &c., for giving instruction in science and navigation, towards the purchase of which the Science and Art Department is authorized to pay 50 per cent. of cost; and they consider that the fullest opportunities should be given to manufacturers in all parts of the Kingdom for supplying such apparatus, &c. At the same time it is necessary that the Science and Art Department should have some guarantee that the apparatus and instruments are of good quality, and moderate in price. My Lords have therefore laid down the following rules and conditions:—

- "1. Samples of all articles on the manufacturer's list are to be sent to the Educational Collection, South Kensington Museum, for exhibition, where they will be arranged separately, according to the science for which they are intended, so as to afford teachers and others facility in inspecting them and making a choice.
- "2. The manufacturer is to supply priced catalogues of such articles printed in demy 8vo., in order that the various catalogues may be bound up together and supplied when asked for.
- "3. The manufacturer is to guarantee that the articles exhibited are fair samples of those specified in the priced catalogue, and he must engage to take back any article supplied to schools which may be inferior to the standard."

Manufacturers willing to comply with these conditions are to make a statement to that effect, and to send lists of apparatus, instruments, books, &c. in the following sciences:—1. Practical plane and descriptive geometry, mechanical and machine drawing, and building construction; 2. Physics (mechanical and experimental); 3. Chemistry; 4. Geology and mineralogy; 5. Natural history (zoology and botany, vegetable and animal physiology); 6. Navigation and nautical astronomy, and physical

geography. If these lists and prices are such as can be approved of, the manufacturer will be informed, and as soon as possible on his fulfilling the conditions, his list will be inserted in the catalogue. The catalogue will undergo a revision at least once a year, when manufacturers may send any improved forms of apparatus, &c.

The selection of the manufacturer will lie wholly with the Committee of the school. On their demand being sanctioned, the manufacturer will receive instructions to supply the articles upon his receiving the 50 per cent. due from the school.

On obtaining a receipt from the Committee of the school (which is included in the form of the requisition) that the articles have been received, the remaining 50 per cent. will be paid quarterly to the manufacturer by the Department.

2. Payments, including charge for packing, must be made in advance to the agents on receipt of the invoice. The goods to be sent at the risk of the purchaser.

All communications to be addressed to the Secretary of the Science and Art Department, South Kensington, London, W.

By Order of the Committee of Council on Education.

N.B.—Apparatus grants will in future be rigorously confined to articles of a permanent and non-destructible nature; hence no aid will be afforded in the purchase of breakable articles, such as glass retorts, test tubes, &c., or, indeed, generally in the purchase of articles to be used by the student as distinguished from those of a permanent and illustrative character which are required by the teacher in giving instruction in science.

SCIENCE FORM, No. 49.

FORM of REQUISITION which may be had on application to the Secretary, Science and Art Department.

The following Requisition for Aid in purchasing apparatus, &c., after being filled up as required, is to be transmitted to "The Secretary of the Science and Art Department, South Kensington, London. W."

	N.B.—It is to be u furnished to public them; they cannot t	institutions to t		a lien on the appublic aid given in	aratus, &c., 1 supplying			
No. 1 appli- cation to be	For the use of			School or Ins	stitution (*)			
filled in by	In the City or Town	of (*)						
Requisition- ist, with	In the County of-							
full par		Male Female	1					
ticulars.	Having (a) Erase the words that do not apply.		(a) Pupils (Artizan Class.	sor Operatives) of	the Science			
	and		(°) Scholars or Me chanics Institute		hool or Me-			
			Total.					
	I request the aid of the Department in obtaining from M the apparatus, &c., named in the opposite page, and I undertake that the same shall be kept and used in the above-mentioned (*) school or institution for which they have been demanded. The address to which the parcel is to be sent is as follows:— To be forwarded to							
	per		at	N' 4 AT				
	Date	d this	day of	Signature of Requ	usitionist.			
	Dun							
No. 2 to be filled in by the Depart-ment.		given for the su	of	186 the extent	Agent,			
		Net	Sum					
	of which & the cost of packing applied.	—will be paid by ug, by the sch	the Department, an pol or institution,	d &, to previous to the a				
No. 3 to be		es sent to Requi	itionist as under, th	is	day			
filled in by agent on transmis-	Deduct as abo	Articles (Retail ve,—	Price)	- e				
sion of the invoice.	Aid by I	Department -			_			
	Δ	dd, for packing		· · ·				
	Total	to be paid by R	equisitionist -	· · ·				
Nos. 4 and to be filled in by agent.		recei	ved from schools this	3	day of			
	5. Examples forward day of ———————————————————————————————————	arded as directed	above, together wit	h Requisition, this				
No. 6 to be filled in by	day of	r invoice receive	l, and *Requisition r					
Requisition ist.	•			Requ	uisitionist.			

 $^{^{\}bullet}$ It is requested this paper may be returned to the Agent in an entire state after the examples have been received.

SCIENCE FORM, No. 91.

Rules for the Conduct of Science Examinations.

1. The following rules must be hung up in the examination room for the information of the candidates one week before the examination. They should all be carefully read by the members of the Committee. Those marked with an asterisk must be read aloud before the Committee and the candidates on each night immediately before the examination begins.

2. A room or rooms of such a size that, when seated, the candidates shall be at least five feet apart, from centre to centre, must be provided

for the examination.

*3. All Diagrams, &c. must be removed from the walls of the examination room.

4. Ink and blotting paper must be provided.

5. If one room is used three of the Committee must be present during the whole of the examination, if more than one room then two of the Committee per room, + who must carefully watch the whole examination and see that candidates use no unfair means either by assisting one another or using books or notes. The members of the Committee can, if they wish it, relieve one another, so long as the correct number are always present.

6. The examination papers will be forwarded, under cover, to the Secretary of the Committee so as to be received by him on the morning

of the day before that fixed for the examination.

*7. The candidates must be seated at their places at 6.50 p.m. After this time no candidate shall be admitted except under very exceptional circumstances, and that only by express permission of the Committee and if no person who has seen the examination paper has left the room. No candidate may on any account be admitted after 7.30 p.m.

*8. The examination papers must be opened in the examination room in the presence of the Committee, at 6.55 p.m. No examination paper

may be taken from the room till after 8 p.m.

*9. When the candidates are seated and the papers given out, the Committee will see that the candidates commence by filling in their names, &c., where directed. All the worked papers must be collected at 10 p.m., initialed, put under cover, and sealed in the presence of the members of the Committee; and forwarded by the first post to the Secretary of the Science and Art Department.

* 10. Candidates must on no account bring anything with them into the examination room, texcept pens and pencils. No scribbling paper, slates, or anything of that nature must be allowed. Arrangements must be made by which all books, note-books, &c., can be given up and left at the

door.

* 11. Candidates must not on any pretence whatever speak to one another after the papers have been given out. § If a candidate should require to ask a question, he will hold up his hand, when a member of the Committee will attend to him, but no question on the meaning of any portion of the examination paper must be asked or answered.

12. It may be of service to the Committee that the teacher of the

[†] When there are not more than three candidates it will not be necessary for more than two members of the Committee to be present at the examination.

‡ Except in the drawing examination, when drawing instruments are allowed. § It is absolutely necessary that nothing that can be passed from one candidate to another should be allowed. Rough work and calculations must be done on the supplied form, the back of each leaf of the form, i.e., pages 2, 4, 6, and 8, may be reserved for this purpose, the pen being drawn through to show that they are not for the examiner. But nothing misst be torn off the form.

class should attend before the examination to assist in getting the candidates into their places, &c.; but from the peculiar character of the examination begins it is so very necessary that not the slightest opportunity for misconstruction should exist that it is evident that he should not be in the room after the examination papers are opened. Information of his having remained in the room after this will at once lead to the examination being declared null.*

*13. The examination papers being given out no candidate must be allowed to return after having once left the room. † On a candidate

leaving the room his papers must be taken up.

* 14. At 10 p.m., precisely, all the candidates must cease working, and members of the Committee will collect their worked papers from them at their places. It will therefore be advisable to warn them ten minutes before the time. The papers will be initialed, by the Committee as directed, as they are received from each candidate, as a guarantee that each has been worked by him whose name, &c., it bears. Should a candidate have completed his work before 10 p.m. he may, by permission of the Committee, go away at once, after his worked paper has been taken by a member of the Committee.

* 15. Should a candidate break any of the foregoing rules, ask from or give information to another, or use unfair means of any description, he must be at once expelled the examination room, and his paper cancelled,

and the Committee will state on it the cause of his expulsion.

16. On these examinations depend large grants of public money. their being fairly, honestly, and impartially carried out depends the continuance of the system. The Committees are intrusted with this duty. They will see, then, how necessary it is to be extremely careful in conducting them, and to insist on the foregoing rules being complied with to the letter. They are therefore required to sign and forward this form with each set of worked papers. We, the undersigned, members of the Committee of the Science

School or Class held at		
hereby certify that we wer	e present during the held in the	he examination in
on the evening of the papers were worked in our prebeen strictly complied with.	sence, and that the fo	e the accompanying pregoing rules have
Dated this	day of	186 .
Signatures.		Time Present.
	 	

retire within the room.

^{*} Should the teacher of the class wish to compete at this examination for the Royal Exhibitions of the Royal School of Mines, he must apply specially to the Committee for permission, so that they may arrange to have a table for him close to their own seats, and not with the other candidates.

† It will, therefore, be desirable to make some arrangement for the candidates to

SYLLABUS OF THE SUBJECTS IN WHICH CERTIFI-CATES AS TEACHERS OF SCIENCE ARE GIVEN BY THE DEPARTMENT OF SCIENCE AND ART.

THE following Syllabus has been prepared in order to afford candidates for certificates as teachers of Science, some guide to their reading; but it must be understood that the questions in the examination need not

necessarily be on the specific points enumerated.

The examination is by paper, but oral examination may be resorted to, and satisfactory evidence may be required of the teacher's power of giving information to a class. The groups are divided as shown, the examination in each subject being distinct, so that candidates may, if they desire it, take a certificate only in one subject of a group. Mention is made of text-books solely to afford a candidate some assistance in selection and a general idea of the scope of the examination, and not at all to confine his reading to those works or to assert that they are the best on the subjects they treat of.

Any certificate obtained at the examination may be raised, by reexamination, in the next or any following November to a higher grade.

A Course of Lectures as detailed below, on "Preparation for obtaining " Science Certificates and the Method of teaching a Science Class," has been delivered by direction of the Lords of the Committee of Council on Education. The lectures may be purchased, price 2d. each, at the book stall, South Kensington Museum. or on application by letter, enclosing postage stamps, to the Secretary, Department of Science and Art, South Kensington, London, W.

- Group I. Geometrical Drawing, &c. Prof. T. Bradley. ,, II. Mechanical Physics Rev. B. M. Cowie - Rev. B. M. Cowie, M.A.
 - Prof. Tyndall, F.R.S. III.- Experimental Physics ,,
 - IV. Chemistry -- Prof. Hofmann, F.R.S. ,, V. - Geology - Prof. Ramsay, F.R.S.
 - Prof.W. W. Smyth, M.A., F.R.S. Mineralogy, &c.

- Prof. Huxley, F.R.S. -.,

VI. - Zoology -VII. Botany -- Edwin Lankester, M.D., F.R.S. ., Navigation and Nautical J. Riddle, F.R.A.S.

> Astronomy. Physical Geography - Dr. G. Kinkel, F.R.G.S.

A Second Course has been delivered, of which the following have been published:--

Lecture I. - Vegetable Physio- Edwin Lankester, M.D., 3rd February. F.R.S. logy and Economic Botany.

Lecture II. Mechanical Physics Rev. B. M. Cowie, B.D. 10th February. Lecture IV. Mining - W. W. Smyth, M.A., 24th February. F.R.S.

SYLLABUS.

A teacher will not receive any payments for Subjects II. or III. until he is certificated in I.

Subject I.—Practical Plane, and Descriptive Geometry.

Practical Geometry, plane and solid; required by architects, engineers, mechanists, shipbuilders, and others employed in arts of construction.

The candidate is expected to have acquired readiness in the use of the usual drawing instruments and materials, to be skilful in drawing lines and circles in Indian ink, plain or dotted, of different degrees of fineness; drawing parallel equi-distant lines, at least six inches long, and from five to twenty or thirty in an inch; drawing from ten to thirty lines, passing through one point and forming equal angles; dividing by trial lines and arcs into any number of equal parts. He should also be able to mend his drawing pens and other instruments, and to verify his rulers, &c.

Constructions in Plane Geometry.

 To draw lines through given points, in every position, either parallel, perpendicular to, or to form any proposed oblique angle, with given lines.

The use and construction of the protractor, and of the "scale of chords" for these purposes, should be understood, and the deduction of certain angles from the direct division of the circle.

To draw circles or arcs, through given points, to touch given lines or circles, and, conversely, lines to touch circles.

> Required in drawing framework for machinery, architectural designs, or namentation, &c.

The principles of drawing symmetrical forms by means of co-ordinates to the axis of symmetry.

This is the basis of all drawing, of all objects of construction, which are universally symmetrical, not only in architecture, civil and naval, but in machinery and engineering works of all kinds.

 Constructions of figures similar to given rectilinear or mixtilinear figures.

Here the construction and use of "scales" plain and comparative, should be thoroughly understood and explained, and the principles of the diagonal and the vernier subdivision. Also the mode of reducing or enlarging drawings by means of similar rectangles, termed squaring a drawing. The use of the sector and of proportional compasses, and of the pentagraph and eidograph, in facilitating copying should be known.

- To construct rectilinear figures similar to given ones, but with a proposed area.
- 6. To determine by construction numerical quantities such as \sqrt{m} ; $\sqrt{a^2 + b^2}$, &c.

7. To construct a triangle, any three parts being given.

Used in levelling, surveying, and the determination of heights and distances. Great accuracy, neatness, and distinctness of construction, will be insisted on: Geometrical drawing is valueless unless it possesses these requisites. A few illustrations of constructions on the ground, by means of a "chain," pins and cords, necessary in surveying, and "setting out" buildings and earthworks, may be added to the course, as well as the solution of a few elementary problems by means of the compasses alone.

8. The delineation of a few of the curve lines required in the arts, such as the ellipse, cycloidal curves, the involute and sinusoid, with the graphical method of determining their tangents and normals.

Required in designing elliptic arches, oblique bridges, teeth of wheels, cam-work, screws, &c.

- Practice in tinting and shading with Indian ink, so as to express curved surfaces and shadows.
- For the preceding part of the course, a fair knowledge of the first six books of Euclid is strongly enjoined, some acquaintance also with trigonometry will be of service, as without such previous knowledge, the learner is simply copying what is set before him, and cannot attain the highest skill in drawing.

Constructions in Solid Geometry.

(Descriptive Geometry.)

Preceded by explanations of the term projection, and of the necessity for it, in order to express graphically, on a surface, solids of any kind; the distinction between orthographic and perspective projections; their uses, and general principles which are the foundation of their practical application.

Orthographic Projection.

- Why the projections, of any solid consisting of a combination of geometric forms, on two or three co-ordinate planes are necessary to show the form and dimensions of that solid.
- Meaning of the terms plan, elevation, profile, section. The principle of the representation of surfaces by the projections of their generators, or of equi-distant horizontal sections termed contours. The direction and inclination of an indefinitely extended plane given by its contours, or by its traces on any two co-ordinate planes.
- These principles should be quite familiar to the candidate, and will be tested by making him draw plans, elevations, and sections of simple solids, as prisms, pyramids, cones, spheres, cylinders, and of symmetrical solids formed by their combinations.
- A few of the problems relating to points, lines, planes, and curved surfaces, will be required, as—
- To draw lines and planes parallel or perpendicular to each other, to contain given points or lines, and the limits of the possibility of solution of any problem should always be understood.
- The preceding constructions combined and applied to determine by their projections the simple solids before mentioned, when they are not symmetrically situated with respect to the supposed planes of projection.

Applications to the intersections of surfaces, and of the development of such as admit of it.

This may be considered the most important part of descriptive geometry to the artizan, as it is required in all arts of construction. The mason, carpenter, and shipwright, workers in tin-plate, boiler makers, &c., would all be benefited by a knowledge of it.

all be benefited by a knowledge of it.

This application has been termed Stereotomy, and better and more

significantly in French, "Coupe de pierres."

Much practical knowledge of the subject, arising from their pursuits, is possessed by workmen, while the want of a scientific knowledge of it compels architects, engineers, and their drawing clerks to leave to the workmen the execution of their conceptions which they cannot themselves design.

4. The solution by construction of the spherical triangle from any three given parts, is mentioned.

As important to masters, mates, and others engaged in any kind of astronomical calculations.

Isometric Projection.

Is usefully employed in the representation of works chiefly of a rectangular form, such as timber framing, canal-locks, and many parts of machinery; its use is much increasing: it is readily understood, and can be practised by anyone who has gone through the first two articles of this section.

Perspective Projection.

May be taken up, but will not be insisted on as it is rarely used except by architects to represent buildings (not yet executed), as they would appear to the eye at any spot from which they could be viewed, and the power of applying it for this purpose is possessed by many who know little of the really easier subject of descriptive geometry; but as its application by the architect must be subordinated to artistic taste, this consideration excludes it, in some measure, from a purely geometrical course.

No one, however, can be considered a scientific draughtsman unless he can apply perspective projection to the projection of shadows, the projections of the sphere, the constructions of maps and dials, and

some other uses.

For the second division of this course, in addition to what was before indicated, a competent knowledge of the theorems relating to the line and plane (Euclid, Book XI.), and an acquaintance with the leading properties of the conic sections, the geometry of the sphere, and some spherical trigonometry is important, it cannot be too urgently recommended to all persons wishing to master this course, to study such works as "Geometry, Plane, Solid, and Spherical" of the Library of Useful Knowledge, and Mr. Bell's, in Chambers' Educational Course.

Geometry, Plain, Solid, and Spherical (Library of Useful Knowledge) is especially recommended as a work to be studied on Theoretical Geometry.

Text-Books for Practical Plane Geometry.—Bradley's Geometrical Drawing; Burchett's Practical Geometry; Practical Geometry, Linear Per-

spective and Projection (Library of Useful Knowledge).

For Descriptive Geometry.—Bradley's Geometrical Drawing; Hall's Elements of Descriptive Geometry for Students in Engineering.—Heather's Descriptive Geometry. Also the following French Works, which are mentioned in consequence of the great deficiency of English Works on Geometrical Drawing.—Elémens de Géométrie Descriptive, par S. F. Lacroix; Traité de Géométrie Descriptive, par Levebure de Fourcy;

Nouveau Cours raisonné de Dessin Industriel, par Armengaud, aîné, et Armengaud, jeune, et Amouroux; Bardin's Works on Descriptive Geometry.

Subject II.—Mechanical and Machine Drawing.

- The candidates in Subjects II. and III. will, some time before the examination, have specifications of subjects given to them, of which they will be required to prepare drawings before the examination. These drawings must be bond fide their own. The candidates may be examined on them, and if the results be satisfactory, they will count towards their certificates, but they will only be taken into consideration when it is clearly seen from the regular examination that the candidate is qualified for a certificate.
- The application of the foregoing Subject I. to the drawing of machinery, in which great accuracy and neatness of drawing will be insisted on.
- The candidate will be required to take measurements with calipers, &c., and to make drawings, elevations, and sections of a simple machine, or of parts of one, set before him. Also to draw a portion of a machine from written dimensions and description. He will be required to have sufficient knowledge of the principles of machinery, gearing, &c., to be able to make working drawings of a machine or portions of a machine from a rough sketch, applying the power to the greatest advantage, and obtaining such power or changes of motion as are required. In fine, such knowledge and readiness as would be required of a good draughtsman in an engineer's office.

Subject III.—Building Construction, or Naval Architecture.

(See previous Subject.)

- The candidate will be required to possess sufficient knowledge of construction—(1) to apply the various materials used in building to their greatest advantage; (2) to be able to make detail and working drawings showing a knowledge of the methods of construction and the framing of ordinary roofs, bridges, &c., whether of wood, iron, or masonry; (3) to frame estimates and take out quantities.
- Neatness, accuracy, and facility in drawing will be insisted on, and the general requirements in this Subject will be such as would be possessed by a good draughtsman in an architect or builder's office, with a slight scientific knowledge for the proper application of the materials he is required to work with.
- N.B.—Naval Architecture may be taken instead of Building Construction; the same description of attainments will be required.

Subject IV.—Elementary Mathematics.

1. Arithmetic generally.

2. Geometry.—The properties of lines, triangles, rectilinear figures, the circle; properties of similar figures; proportion of figures; inscribed and circumscribed polygons. The questions will have reference to Euclid's elements; but a sound knowledge of Geometry obtained from any source will be accepted.

 Algebra.—Definitions. Addition. Subtraction. Multiplication. Division. Greatest common measure. Least common multiple. Theory of indices (integral). Involution. Evolution. Simple equations, and problems producing them. Fractions. Quadratic equations, and problems producing them. Ratio. Proportion. Variation. Arithmetical, geometrical, and harmonical Progressions, Permutations, and Combinations. Binomial theorem for a positive

integral index.

4. Plane Trigonometry.—Definitions. Conversion of degrees and their subdivisions into grades, and their subdivisions, and vice versa. Angular and circular measures of degrees and their relation. The goniometric functions of angles and the conversion of one into another. The arithmetical values of the goniometric functions of 90°, 45°, 60°, 30°, 180°, 120°, 150°, &c. The meaning of contrariety of signs in trigonometry. Tracing of the goniometric functions in magnitude and algebraic sign through the four quadrants and when an angle is indefinitely increased.

Formulæ for multiplication and division of angles, viz., sine, cosine, tangent, &c., of $(A \pm B)$, 2A, 3A, $\frac{A}{2}$, and $\frac{A}{3}$. Also of A and B in

terms of
$$\frac{A+B}{2}$$
 and $\frac{A-B}{2}$.

Logarithms.—Definition. Multiplication, Division, Involution and Evolution by logs. The use of logarithmic tables. Tables of proportional parts for numbers and angles. Modulus. Construction of logarithmic tables, and of tables of logarithmic sines, cosines, &c.

Triangles.—Formulæ for cosine of an angle of a triangle in terms of its sides. The relation between sines of angles and the opposite sides; sine, cosine, tangent, &c., of half an angle of a triangle in terms of sides, and of the sine of an angle. Area of a triangle. Solution of triangles. Diameters of circles inscribed in and circumscribed about a given triangle. Areas of regular polygons inscribed in and circumscribed about a given circle. Area of a circle. Description and use of vernier and theodolite and sextant (generally). Heights and distances of inaccessible objects.

For students to pass, a competent knowledge of the following alone will be required:—

(1.) Geometry. The first book of Euclid.

(2.) Algebra, to simple equations and problems (inclusive).

(3.) Plane trigonometry. The more elementary portions, including use of logarithms.

To obtain an honourable mention:-

(1.) Geometry. The first three books of Euclid.

(2.) Algebra, to quadratic equations.

(3.) Plane trigonometry as far as solution of triangles, inclusive.

And for third, second, and first class Queen's prizes the remaining portion of the above subjects.

Subject V.—Higher Mathematics.

 Algebra.—Surds. Theory of indices (fractional and negative). Binomial theorem generally. Multinomial theorem. Exponential theorem. Indeterminate equations and problems. Indeterminate coefficients. Reversion of series. Properties of numbers.

2. Plane Trigonometry.—De Moivre's theorem and the expansion of

sine, cosine, and tangent in terms of the angle.

Spherical Trigonometry.—Definitions and fundamental propositions.

Polar or supplemental triangle and its properties. Area of a spherical triangle. Spherical excess.

Fundamental formulæ expressing the relations of the sides and angles of a spherical triangle.

Napier's analogies.

Solution of right-angled spherical triangles and of oblique angled triangles.

Mensuration.—Trapeziums. Regular plane rectilinear figures. Irregular plane curvilinear figures (Simpson's or Stirling's Rules). Volumes and surfaces of Parallelopipeds, Pyramids, Cylinders, Cones, and Spheres.

Differential and Integral Calculus.—Definitions. Differential of elementary functions, including circular and logarithmic functions. Vanishing fractions. Maxima and minima of one independent Tangents and normals of curves. Differential coefficients of Areas, Arcs, Volumes and surfaces of solids of revolution.

Integration of elementary functions. Integration by parts. Rational Integration between limits. Areas and lengths of simple curves. Volumes and surfaces of solids of revolution.

Subject VI.-Mechanics as a Science, or Theoretical Mechanics.

Statics. Composition and resolution of forces. Forces acting on a point—on a rigid body. Parallel forces. Centre of gravity. Theory of moments or couples. Principle of virtual velocities. The mechanical powers. Friction. Equilibrium of roofs and arches.

Dynamics. Laws of motion. Uniformly accelerated motion. Motion by gravity Variable forces. Projectiles. Centrifugal force. Motion on inclined planes—on curves. Pendulums. Motion of rigid bodies, free or constrained. Moment of Inertia. Centre of oscillation-of percussion. Motion of flexible bodies, such as a musical string.

Hydrostatics, Hydrodynamics, and Pneumatics. Mechanical properties of liquids. Law of pressure. Centre of pressure. Laws of floating bodies. Capillary attraction. Laws of fluid motion, through open channels, closed pipes, or orifices.

Mechanical properties of elastic fluids. Theory of barometers. Connexion between pressure, temperature, and volume. Specific heat. Weight of atmosphere. Use of barometer in calculating heights.

In this subject the candidate will have to show a mathematical knowledge of the laws of Mechanics, and must be able to prove from first principles the principal theorems.

The books recommended for study are—Whewell's Elements of Mechanics, or Snowball's; Moseley's Engineering Architecture; Natural Philosophy, by Dr. Golding Bird and Mr. Brooke; Goodwin's Elementary Course.

Subject VII.—Mechanics as an Art, or Applied Mechanics.

General principles of mechanism. Elementary combinations. When the connexion is by rolling contact, sliding contact, wrapping connectors or linkwork, with constant or varying velocity ratio, and constant or

varying directional relation.

Machines of ordinary occurrence must be thoroughly understood and particular parts to be described and drawn : such as cranes; lathes; drills: planing, punching, boring, shaping, and slotting machines. Spinning and weaving machinery. Mode of calculating power of machinery. Dynamometers, indicators, &c.

Materials. The general properties of materials. Elasticity. Weight. Specific weight. Mechanical work. Work done by pressure, by

impact, by expansion of elastic gases and steam, by animal muscular effort.

Resistance to expansion, to compression, to rupture. Friction of Its importance in construction. Resistance of fluids to bodies moving within them. Adaptation of form and material for maximum resistance. Beams of greatest strength. Construction of roofs, arches, stone and timber bridges, suspension bridges, and tubular girders.

Hydrostatics, Hydrodynamics, and Pneumatics. Pressure on floodgates; locks; water-wheels; turbines; water-pressure engines; breakwaters. Hydrometers. The syphon. Hydraulic ram. Fumps. Diving bell. Condenser. Windmills. Steam-engines, stationary, marine, locomotive. The steam hammer. Water supply to towns. Theory of tides, in the open sea, and in rivers.

In this subject the candidate will be expected to show how the principles are applied in actual practice: he will be expected to show by clear well-drawn sketches, his acquaintance with parts of machines.

The candidate will have tools and models put before him, with some of which he must show he is familiar, and that he can explain their use

and construction.

Books recommended: -Willis's Mechanism; Baker's Elements of Mechanism; the books in Weale's Series which treat on the subjects specified. Twisden's Practical Mechanics; Goodeve's Elements of Mechanism.

Subject VIII.—Acoustics, Light, and Heat.

Acoustics.

The candidate ought to know the manner in which sound originates, and is propagated; its velocity in different media, and how its velocity

through air is affected by density and temperature.

He ought to know the origin of musical sounds; of pitch; of harmony and discord; to commit to memory the rates of vibration of the several notes of the gamut; to be able to make sonorous vibrations visible by means of glass plates and membranes; to calculate the length of sonorous waves, and to determine practically the number of vibrations due to any particular note. He ought therefore to understand the construction and use of the Syren.

He ought to be able to describe and illustrate the condition of a vibrating string, or column of air at its nodal points and ventral segments and

to explain echos and resonance.

Light.

The candidate ought to know how its velocity was first determined from

observations upon Jupiter's satellites.

He ought to be able to devise a simple means of exhibiting both the reflection and refraction of light; to be able to state the laws of both; to explain what is meant by total reflection; and to apply it to the explanation of the Mirage of the Desert, the Phantom Ship, and other similar phenomena.

He ought to be able to explain why the image in a plane mirror must appear as far behind the mirror as the object is in front of it; why a stick appears bent when dipped obliquely into water; and why the hottom of a river or lake, or of a basin which holds water, appears to

be nearer to the surface than it really is.

He ought to be able to determine the positions of the foci of spherical mirrors, both concave and convex; to describe the characters of their images, whether erect or inverted; magnified or reduced; and to do the same for convergent and divergent lenses.

He ought to know the construction of the human eye; the conditions of distinct vision, the use of spectacles; and to be able to describe a simple form of the reflecting and refracting telescope and of the microscope.

He ought to know the constitution of light; to be able to describe the spectrum produced by refraction with a prism; to explain the origin

of colours, and to give a clear explanation of the rainbow.

Heat.

The candidate ought to be able to describe the construction and graduation of an ordinary mercurial thermometer; to understand the scales of Fahrenheit, Celsius, and Reaumur.

He ought to have clear ideas of conduction and radiation; to be able to devise some simple means whereby the conductive and radiative powers of different bodies may be determined; to explain fully the formation

of dew, and to state the conditions favourable to its production.

He ought to know the effect of heat upon the volumes of bodies; to know what is meant by the coefficient of expansion, and how it may be determined; to give illustrations of the enormous power of heat in producing expansion; to state exceptional cases; to know the manner in which heat is propagated through liquids and gases, as distinguished from ordinary conduction; and to be able to combine two metals possessing different coefficients of expansion, so as to form a compensating pendulum.

He ought to know the meaning of latent heat and of specific heat, and to illustrate both by reference to ice, water, and steam; he ought to be able to show the influence of the high specific heat of water upon

an island climate.

He ought to know the strict physical meaning of ebullition; and the influence of pressure upon the boiling points of liquids; he ought to have a general knowledge of the origin of winds and clouds, and to be able to explain the fact that the rain-fall upon the south-west side of a mountain chain in England and Ireland is much more copious than on the north-east side.

Subject IX.—Magnetism and Electricity.

Magnetism.

The candidate ought to know the action of one loadstone upon another which is freely suspended, or set afloat upon a liquid; he must have a perfectly clear notion of magnetic polarity, and of the action of magnetic poles upon each other.

He must know the difference between the action of magnetised and unmagnetised steel upon a magnetic needle; also the difference between soft iron and hard steel, with regard to their acceptance and

retention of the magnetic condition; (coercive force).

He must be able clearly to state the condition of a mass of soft iron when under the influence of a magnet, and in virtue of which condi-

tion the iron is attracted; (magnetic induction).

He must be able to describe the action of the earth upon a magnetic needle; must know the meaning of declination, inclination or dip, and of secular and diurnal variation; the action of the earth upon a bar of soft iron according as it is held in the direction of the dip or at right angles to this direction; finally, the effect of percussion in rendering the condition assumed by the bar of soft iron a permanent one.

He ought to be able to compare accurately the strength of one magnet with that of another, and to state how the relative intensity of the earth's magnetism at two points of its surface may be ascertained.

Frictional Electricity.

The candidate ought to know various simple ways of exciting electricity to be clearly informed as to the duplex character of the force; to know the condition of the rubber as well as that of the body rubbed; and to be conversant with various forms of electroscopes and electrometers.

He ought to know the foundation of the terms vitreous and resinous, positive and negative; to be able to illustrate the action of two electrified bodies upon each other; and to tell at once whether a body is

positively or negatively charged.

He ought to have a clear knowledge of electric conduction, insulation, and induction; and be able to explain the state of a neutral conductor when acted upon by an electrified body; he ought to be able to prove, experimentally, that though we cannot by breaking a magnet obtain two halves each with a single pole, we can by breaking an electrified body obtain two halves each charged with a single electricity.

He ought to be able to explain the influence of points and flames when attached to an electrified conductor; and to describe the action of

lightning conductors.

He ought to be able to describe the electric machine, and the electrophorus; and to explain the action of the condenser and of the Leyden jar.

He ought to be able to state the principal effects of the electric discharge; to state the atmospheric conditions necessary to the production of a thunderstorm; and to give a clear account of the so-called return stroke.

Voltaic Electricity.

The candidate ought to be able to state precisely how voltaic electricity may be generated; to describe Volta's pile, and his crown of cups;

and also the batteries of Daniell, Grove, and Bunsen.

He must have a clear conception of what is meant by the direction of an electric current; and be able to illustrate in the fullest manner the action of a current upon a freely suspended magnetic needle. Given the direction of the current, he must be able to state how the needle moves; given the movement of the needle, he must be able to infer from it the direction of the current.

He must be able to describe fully the action of a current upon soft iron; and to infer from the direction of the current the nature and position

of the magnetic poles, which it excites.

He must be well acquainted with the chemical reactions which take place both in the batteries, mentioned above, and also in other liquids

through which the current may be sent.

He must be able to measure the strength of an electric current, and he is strongly recommended to master thoroughly the law of Ohm, regarding the mutual relations of electromotive force, resistance, and strength of current.

He ought to be acquainted with the so-called polarisation of metallic plates between which a current passes through a liquid, and to show

how this is avoided in Grove's battery.

He ought to be able to give a clear description of some one form of the

electric telegraph.

He ought to be acquainted with the physiological effects, and with those of light and heat produced by the voltaic current; and to show the dependence of the heat on the atrength of the current, and on the resistance which it encounters.

It would also be well to master as much of the phenomena of induced currents as would enable the candidate to explain the action of the

galvanizing apparatus used by medical men.

Note.—This candidate will perceive that this list is long because the objects to which he is to devote his attention are separately specified. Definition is thus given to his studies and their precise scope marked out for him. He is recommended to repeat with his own hands, as far as it is in his power to do so, the experiments which he finds described in good handbooks of Natural Philosophy; this will give a certainty to his knowledge and an interest to his pursuits which mere reading can never confer. The first requisite demanded of him on his examination will be that, however small his knowledge, it shall be well digested and sound,

'Text-Books:—Lardner's Handbook of Natural Philosophy; Natural Philosophy, by Dr. Golding Bird and Mr. Brooke.

Subject X.—Inorganic Chemistry.

The general principles of chemical philosophy. Laws of combination. Combining weights and chemical equivalents. Combining volumes. Chemical symbols and their use in the explanation of chemical changes. The atomic theory.

The non-metallic elements: Oxygen. Combustion.

Hydrogen. Water. Chemical composition and properties. Adaptation for domestic purposes. Hardness, permanent and temporary.

Nitrous oxide, nitric oxide. Nitric acid. Nitrification. Nitrogen.

Ammonia.

Process of carbonization. Carbonic oxide. Carbonic acid. Marsh gas. Olefiant gas. Manufacture of coal gas.

Sulphur. Sulphurous acid, sulphuric acid. Sulphuretted hydrogen.

Bisulphide of carbon.

Chlorine. Hypochlorous acid. Bleaching agents and theory of bleach-Chloric acid and perchloric acid. Chloride of nitrogen. Chlorides of carbon.

Bromine. Bromic acid and hydrobromic acid.

Iodine. Iodic acid, periodic acid, and hydriodic acid.

Fluorine. Hydrofluoric acid.

Phosphorus. Hypophosphorous acid, phosphorous acid. The several modifications of phosphoric acid: ordinary phosphoric, pyrophosphoric, and metaphosphoric acids. Theory of polybasic acids. Phosphoretted hydrogen. Chlorides of phosphorus. Manufacture of matches.

Boron and boracic acid. Silicium and silicic acid.

The metals: Potassium. Manufacture of nitre. Manufacture of gunpowder. Theory of the action of gunpowder. Sodium. Manufacture of carbonate of soda.

Barium. Strontium. Calcium. Mortars.

Magnesium, Aluminium. Manufacture of glass and porcelain.

Manganese. Iron. Composition and properties of cast iron, wrought iron, and steel.

Cobalt. Nickel. Chromium. Zinc. Cadmium. Copper. Lead. Manufacture of white lead.

Bismuth. Mercury. Tin. Arsenic. Course of analysis in cases of

poisoning.

Antimony. Silver. Gold, and platinum. Their principal compounds with the non-metallic elements.

Outline of qualitative analysis. Reactions of the principal mineral acids and bases. Course pursued in the application of these reactions to the analysis of a mixture of several acids and bases.

The following is the list of Apparatus and Re-agents with which Candidates make their analysis at the examination:—

APPARATUS.

Test tubes and stand.
Metal filter stand.
Wash bottle containing distilled water.
Spirit lamp.
Black blowpipe.
Charcoal for blowpipe experiments.

Iron spoon.
Tongs.
Pestle and mortar.
Porcelain dishes.
Watch glasses.
Porcelain crucible.
Triangles.
Test tube cleaner.

Platinum wire and foil. Funnels.
Cut filters.
Sulphuretted hydrogen apparatus.
Platinum crucible.
Herapath's blowpipe.
Stirring rods.

RE-AGENTS.

Sulphuric acid.
Hydrochloric acid.
Nitric acid.
Hydrosulphuric acid.
Potassa.
Ammonia.
Chloride of ammonium.
Sulphide of ammonium.
Carbonate of ammonium.

In the liquid state.
Phosphate of sodium.
Chloride of barium.
Chloride of calcium.
Lime water.
Sulphate of calcium.
Sulphate of potassium.
Sulphate of magnesium.
Chromate of potassium.
Oxalic acid.
Tartaric acid.

Acetic acid.
Hydrofluosilicic acid.
Oxalate of ammonium.
Acetate of lead.
Sesquichloride of iron.
Ferrocyanide of potassium.
Chloride of platinum.
Nitrate of silver.

Carbonate of sodium. Nitrate of potassium. Cyanide of potassium.

In the solid state.

Borax.
Lime.
Sulphate of iron.

Blue and red litmus paper.

Subject MI.-Organic Chemistry.

Ultimate analysis of organic bodies. Calculation of an empirical formula. Methods of controlling an empirical formula. Determination of the equivalents of organic acids and bases, examination of products of decomposition, determination of the vapour-density of volatile bodies. Law of substitution.

The chemical history of the Cyanogen group. Cyanogen. Hydrocyanic acid. Cyanic acid and urea. Fulminates. Cyanuric acid. Sulpho-

cyanic acid. Chlorides of cyanogen.

Amylaceous and saccharine substances. Fermentation. Alcohol, and its homologues. Ethers, simple and mixed. Oxidation of alcohol, Aldehyde and acetic acid, and their homologues. Anhydrides, simple and mixed. Compound ethers. Diatomic alcohols and their acids. Glycol and oxalic acid. Triatomic alcohols. Glycerine. Fatty and oily bodies.

Ammonia and its derivatives. Amides and amines: their classification.

Examples of natural alkaloids.

Principal colouring matters. Indigo and its derivatives. Examples of products formed by destructive distillation.

The chief constituents of the vegetable and animal organism, fibrin, albumen, casein, &c.

The chemical principles of agriculture.

The chemical principles of the process of nutrition and respiration in the animal organism.

Text-books.—Graham's Elements of Chemistry, Miller's System of Chemistry, Fownes' Manual of Chemistry, Gregory's Outlines of Chemistry, Abel and Bloxam's Handbook of Chemistry, Galloway's Qualitative Analysis.

Subject XII. -Geology.

1. The division of rocks into three great classes, aqueous, igneous, and metamorphic.

2. The mode of formation of stratified rocks,—marine strata—delta formations - freshwater beds, - the sign by which you can distinguish

3. The mode of occurrence of igneous rocks, ashes, lavas, and dykes.

4. Volcanoes and volcanic phenomena.

5. The theory of central heat.

6. Elevation and depression of land.

7. The ordinary mineral substances that enter into the composition of rocks.

8. Fossilization of organic bodies.

9. Table of geological formations, including those larger divisions absent in Britain.

10. Theory of metamorphism of rocks.

British Strata.

1. Description of the Cambrian strata and Silurian strata, their litho-

logical characters, disturbances and chief fossils.

2. Description of the old red sandstone and Devonian rocks, character and fossils. Origin of cleavage. Slate and slate quarries, buildingstones, limestones, and marbles.

3. The carboniferous limestone and coal measures. Character, fossils. and mode of formation. Origin of the coal of the coal-measures, and its mode of occurrence. Mode of occurrence of the ironstone of the coal measures. Various kinds of coal, and the relation of anthracite coal to disturbance of strata. Lime quarries, marbles, and building stones. Clay pits and potteries of the carboniferous strata. Fire clay. Alum shale.
4. The Permian rocks. Their strategraphical relations to the underlying

strata, composition of rocks, fossils, and building-stones.

5. The new red sandstone (or Trias), its subdivisions, fossils, buildingstones, sand pits, rock salt, and brine springs. 6. The Lias. Its subdivisions, chief fossils, building-stones, and other

hydraulic limestones, and clay pits.

7. Oolitic rocks. Subdivisions, leading fossils, building-stones. Limestones. Clay pits, and other economic products.

8. The Purbeck and Wealden strata. Origin, subdivisions, chief fossils, building-stones, and marbles. Ironstones and limestones. Clay pits.

9. Cretaceous rocks. Subdivisions, lithological characters, fossils, building stone of lower greensand. Gault, its phosphatic nodules and general uses. Upper greensand, chalk, &c. Building stones. Origin and uses of chalk-flints.

10. Eccene, or older Tertiary beds. Subdivisions, alternation of marine and freshwater beds, chief fossils, limestones and building stones,

clays for bricks and potteries.

11. Crag. Its subdivisions, chief fossils, phosphatic remains.

12. Disturbance and denudation of strata.

13. Unconformities, faults, and fractures.

- 14. The causes of gaps in the succession of strata, or of breaks in the succession of life in time.
- 15. Water-bearing strata, and underground drainage. Artesian and other wells.

16. British rocks in which ores of metal are found, and the general mode of occurrence of these ores in beds or lodes.

17. The rules that ought to guide the miner in sinking for coal and other minerals, when the beds in which they lie are concealed by over-lying and unconformable strata.

18. The occurrence of stream tin, gold, &c., in superficial detritus.

19. The chief differences in the nature and mode of occurrence of various

formations in areas widely separated from each other.

Text-books.—Lyell's Principles of Geology; Lyell's Elements of Geology; Phillips' Manual of Geology; Jukes' Manual of Geology; Page's Introductory Text-Book; Page's Advanced Text-Book.

Subject XIII .- Mineralogy.

A. Instruction in this subject should commence with a distinct understanding of the characters by which minerals, properly so called, are to be distinguished from other inorganic substances, and of the position of this science in relation to the collateral sciences of

physics, chemistry, and geology.

B. Crystallography, as the essential means of appreciating the forms naturally assumed by almost all inorganic bodies, must commence with the needful geometrical definitions, proceed to the grouping of the various crystalline forms into systems, consider the laws by which the derivation of one form from another within the limits of the same system is determined, and explain the combination of various simple forms in the faces exhibited by compound crystals. It is also important to study the deviations from regularity which are commonly presented in nature, and the methods of measuring those elements which remain constant.

c. The various kinds of aggregation exhibited by crystalline substances are also to be considered, especially with reference to masses of the

useful minerals, and of crystalline rocks.

D. Next in order will follow the other physical characters of minerals; lst, in relation to their substance, as cleavage, fracture, hardness, and specific gravity: 2ndly, in relation to the effects of light, as transparency, refraction, lustre, and colour; 3rdly, as to their electric and magnetic properties.

E. The chemical characters of minerals, and the most convenient modes of testing them; 1st, by aid of the blowpipe; 2ndly, by the

moist way.

F. Pseudomorphism, or the remarkable phenomena presented by minerals which have the composition of one mineral coupled with the form

of another.

G. The physiography or systematic description of minerals. This last division should include all the more remarkable varieties as well as species, and should take especial note of the modes and places of occurrence, as well as of the association of particular groups of minerals in certain veins or formations.

As text-books may be recommended—

Professor Ansted's Elementary Course of Mineralogy and Geology. London. 1856.

Nicol's Elements of Mineralogy. Edinburgh, 1858.

Dana's Manual of Mineralogy, 1851.

Bristow's Dictionary of Minerals. Longman & Co. 1861.

For more advanced students—

Brooke and Miller's Mineralogy. London, Longman, 1852.

On Crystallography. Rev. W. Mitchell, in Orr's "Circle of the Sciences." London, 1856.

Dana's System of Mineralogy. 4th edition. Putnam, 1854.

Naumann's Mineralogie. Leipzig. Williams and Norgate, London.

Breithaupt's Paragenesis der Mineralien. Freiberg, 1849. Haidinger's Handbuch der Mineralogie. Vienna, 1845.

When it is intended to teach this subject with special reference to the practical working of minerals, the physiographical part will be occupied

more particularly with certain of the useful species and their associated substances, and the following works may be consulted :--

W. J. Henwood on the Metalliferous Deposits of Cornwall and Devon,

Bischof, Chemical and Physical Geology, translated by the Cavendish Society. 1854.

Subject XIV.—Animal Physiology.

The field presented by Natural History is such an exceedingly wide one, that candidates are advised to confine their studies to the subjects enumerated below, and to master these as thoroughly as possible. And as in the Natural Sciences, the knowledge which is obtainable by mere reading is of very little value, candidates are particularly recommended to study nature for themselves, and to become personally acquainted with the primary facts of Biological Science. Thus in Physiology, the fundamental truths relating to circulation, muscular contraction, and nervous action, may all be readily exemplified by simple experiments upon the common frog; and in Systematic Zoology and Botany, the careful study of the structure of the animal and vegetable forms enumerated under the head of "types" will furnish a better conception of the animal and vegetable worlds than any amount of mere reading. Candidates will therefore be expected to be thoroughly and practically acquainted with the fundamental facts of Physiology, and in Zoology, with all the most important and distinctive characteristics of such of these typical genera as are illustrated by British species.

Candidates should have carefully studied what is stated upon the subjects enumerated below in any good handbook of Physiology.

The general properties of living matter in respect of form, structure, and chemical composition. The meaning of the terms organ, organization, function, development. The difference between high and low organization. The division of physiological labour.

Why the living organism wastes. The difference between vital and putrefactive decomposition. The conditions and ultimate products of vital decomposition. The living body considered as a

machine performing a certain amount of work.

Why food is necessary. The difference between the food of plants and that of animals. The nature of the substances which constitute the food of man. The proximate chemical composition of milk, flour, meat, butter, potatoes, oatmeal, peas, rice, tea, coffee, beer, wine, and spirits; and the distinction of the proximate elements of each into nutritious and innutritious.

Why digestion is necessary, and how that function is performed in the human organism. The structure of the organs by which the following substances are formed, and their uses: saliva, gastric juice, pancreatic juice, bile. How the nutritious products of digestion are separated from the excrementitious residuum. The process of absorption. The means by which absorbed matters are conveyed to all parts of the organism. The structure and composition of human

blood. The course and mechanism of the circulation.

Why the elimination of waste products is necessary. Excretion of carbonic acid. The mechanical and physical principles involved in the performance of the respiratory process in man. The excretion of urea and uric acid. The structure of the urinary apparatus, and the mechanical and physical principles involved in its action. excretion of water as a part of the foregoing processes, and as effected by the skin. The structure and other functions of the skin. The mutual relations of the three great excretory apparatuses.

The conditions and sources of animal heat. The circulatory

system of man viewed as a hot-water warming apparatus. The fuel

of the animal economy and its sources.

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Animal mechanics. The human body as a locomotive apparatus. The structure of bones and joints. The structure and properties of muscle.

The structure and functions of nervous matter. The offices of the spinal cord and brain. The nature and mode of action of the sensory organs. Reflex action. Habit, as acquired reflex action. Instinct. Intellectual and emotional operations.

The nature of death, and the difference between general and local

death.

Local death:—1st, as a part of life; e.g. moulting, shedding of skin and teeth. 2nd, as opposed to life; e.g. sloughing and mortification.

General death:—1st, as the natural conclusion of life. 2nd, as arising from disease or injury. Usual commencement of death in

the nervous centres, the heart or the lungs.

Reparative processes:—1st. Local, as exhibited in the reproduction of lost parts, healing of wounds, &c. 2nd. General, as shown in the reproduction of the individual by sexual generation. The origin and development of the embryo. The nutrition of the fectus and of the infant. Hereditary transmission, and the modification of physical and mental characters by education, as the basis of a rational belief in the possibility of human progress.

Subject XV.—Zoology.

 Candidates should have carefully mastered the definitions of the sub-kingdoms, classes, and orders of the Animal Kingdom. They should understand and be able to explain the meaning of the terms employed in such definitions; and they should be able to refer any specimens that may be placed before them to their proper classes.

2. Candidates should be able to give fair answers to questions relating to any or all of the following subjects, and they should be able to identify, refer to their proper orders, and if called upon to do so, describe, the objects enumerated in each section under the head of "types." In almost all cases these "types" are British animals.

By the term Natural History, of such and such an object, is meant such an account of it as is to be found in any standard modern work on

i. The structure and mode of multiplication of infusorial animalcules and Foraminifera. The arguments which have been adduced for and against spontaneous generation. The luminosity of the sea, and the nature of the creatures which chiefly cause it. The natural history of the sponge of commerce. Types—Spongia, Varticella.

ii. The meaning of the terms, zoophyte, coral, coralline. Natural history of the red coral of commerce. Common coral and coral reefs. What such reefs are, where they are formed, and how they grow. Natural history of the common freshwater polype, or hydra, and of the "jelly fishes," or "medusæ" of the sea. A sexual multiplication as exhibited by these creatures. Types—Hydra, Sertularia, Plumularia, Actinia, Corallium, Fungia, Oculina.

iii. Starfishes, sea urchins, and Holothuriæ; their structure and habits, and the metamorphoses which they undergo. Natural and

economical history of Trepang. Types-Uraster, Echinus.

iv. Natural history of the earthworm and the leech. Intestinal worms; their structure, propagation, and mode of entrance into animal bodies. Natural history of the Rotifera. Types—Lumbricus, Hirudo, Distoma, Tænia, Ascaris.

v. Natural history of Crustucea. The lobster and crayfish, as exemplifying morphological and teleological laws. The process of ecdysis. Barnacles, acorn shells, and fish lice, as cases of extreme

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metamorphosis. The water flea as exemplifying a sexual multiplication. Types—Cancer, Homarus, Astacus, Oniscus, Daphnia, Cyclops, Lepas, Balanus, Argulus.

vi. Natural history of spiders, scorpions, and mites. The "itch insect," centipedes, and millipedes. Types—Tegenaria, Scorpio,

Scolopendra, Julus.

vii. Insects; their mode of breathing as contrasted with that of spiders and crustaceans. The structure of their wings, and the mechanism of flight. The parts of the mouth and their modifications in beetles, bees, butterflies, bugs, and gnats. Structure of the eyes. Nature of stings, saws, and ovipositors. Natural and economic history of the blistering beetle, of the silk moth, of the bee, of the cochineal insect. Natural history of plant lice, of bugs, fleas, and lice. The house fly, blow fly, and gnat; wasps, humble bee, ichneumon flies; "black beetles," crickets, and locusts. The metamorphoses of insects. Types—Melolontha, Blatta, Libellula,

Phryganea, Coccus, Aphis, Bombyx, Apis, Vespa, Musca.

viii. The characteristic peculiarities of the nervous, circulatory, respiratory, and locomotive organs of mollusks in general. Organization of "sea mat" (Flustra). Ascidians and "lamp shells" (Terebratula). Natural history of fresh-water and marine mussels. Nature of mother of pearl. Formation of pearls. Pearl fishery. Natural and economical history of the oyster. Organization of snails and slugs, periwinkles, limpets, whelks. Development of the young of the latter. Nidamental capsules. Cuttlefishes and squids. Paper nautilus. Pearly nautilus. The shipworm and Pholas. Mechanism by which mollusks bore. Types—Flustra, Ascidia, Terebratula, Unio, Mytilus, Ostrea, Pecten, Helix, Patella, Littorina, Buccinum, Chiton, Sepia, Loligo, Argonauta, Nautilus.

ix. Circulatory, respiratory, and reproductive organs of fishes. Their dentition. Natural and economical history of the lamprey, sprat, sardine, herring, pilchard, salmon, trout, eel, cod, haddock, sole, flounder, turbot, mackerel, tunny, sturgeon, skate, ray, dog fish, shark. Electrical fishes. Fishes which are capable of living in air. Pisciculture, or the artificial breeding of fishes. Types—Amphiocaus, Petromyzon, Syngnathus, Cyprinus, Perca, Accipenser, Lepidosteus, Raia, Spinax.

x. Natural history of salamanders, newts, frogs, and toads, Metamorphoses undergone by their young. Types—Salamandra,

Triton. Rana.

xi. Circulatory and respiratory organs of reptiles as distinguished from those of fishes and amphibia. Natural history of snakes, lizards, crocodiles, turtles, and tortoises. Tortoise-shell. Shedding of the skin in reptiles. Types—Coluber, Pelias, Anguis, Lacerla, Crocodilus, Testudo, Chelone.

xii. Organs of locomotion, respiration, voice, circulation, and reproduction of birds. Structure and mode of growth of feathers, Development of the fowl's egg. Artificial hatching. Migration, and instincts of birds. Natural history of domestic birds; of the ostrich, the apteryx, the penguin, and the dodo. Types—Falco, Corvus, Columba, Picus, Phasianus, Ardea, Struthio, Anser.

xiii. Organs of respiration, circulation, and reproduction of mammals. Production and nutrition of their young. Placental and implacental mammals. Nature of milk and of the lacteal glands. Peculiarities in the dentition of mammals. Natural and economic history of the domestic mammals; of the ivory and fur yielding mammals; of seals; of whales. The hybernation and migration of mammals. Characters of the orders of mammals. Types—Cercopithecus, Vespertilio, Erinaceus, Lepus, Elephas, Sus,

Cersus, Bos, Ovis, Felis, Phoca, Phocana, Dasypus, Halmaturus, Ornithorhynchus.

xiv. The distinctive peculiarities of man. The characters of the principal races of mankind, and their geographical distribution.

Text-books for Physiology.—Carpenter's Animal Physiology, Bohn, 1859; Dr. Kirke's Manual; Andrew Combe's Physiology applied to Health and Education. For Zoology. - Dallas's Natural History of Animals: Orr's Circle of the Sciences; Gosse's Manual of Marine Zoology; Professor Green's Manual of the Protozoa.

Subject XVI.—Vegetable Physiology and Economic Botany.

In this department the candidate will be expected to answer correctly questions on the following points:-

1. The properties of the principal elements entering into the composition Carbon, oxygen, hydrogen, nitrogen, sulphur, phosof plants. phorus, chlorine, iodine, silicon, potassium, sodium, calcium, iron.

2. The composition and properties of the compounds forming the principal part of the structure of plants. Cellulose, starch, dextrine, sugar, fixed oil, gluten, albumen, caseine. The saline compounds forming the ashes of plants.

3. The composition and properties of peculiar vegetable products. latile oils. Acids. Colouring matters. Alkaloids. Neutral principles.

Chlorophyll.

4. The origin and growth of the vegetable cell. The tissues of plants. Cellular tissue. Intercellular organs. Epidermal tissue. Stomates. Vascular tissue. Woody tissue.

5. The structure and functions of the organs of plants. The root. Spongioles. Absorption and excretion. Nature of vegetable food. The stem. Structure of Exogenous, Endogenous, and Acrogenous stems. The leaf. The forms of leaves. Exhalation. Stipules and bracts. The flower. Calycine, Corollal, Staminal, and Carpellary leaves. Development and nature of pollen. Ovules or seed buds. Vegetable impregnation. Embryo. Seed. Fruits; their nature and forms. The nature of the reproductive organs in flowerless plants.

6. The composition and nature of vegetable substances used by man Distinctions between heat-giving and flesh-forming foods. Structure and geographical distribution of plants yielding starch,

sugar, oil, gluten, albumen, and legumin.

7. Properties of vegetable substances used in the arts and manufactures. Vegetable secretions used as dyes.—Indigo, madder, logwood, red sanders wood, quercitron, alkanet, arnotto, gall-nuts, myrobolans.

8. Materials used in the manufacture of textile fabrics.—Cotton, flax,

hemp, coco-nut, jute, New Zealand flax.

9. Principal forms of timber trees, and their uses.—Oak, mahogany, teak, pine, &c.

10. Nature of tanning principles and plants yielding tannic acid.—Oakbark, valonia, catechu, kino, divi-divi, betel-nut.

11. Gums, oils, and resins used in arts.—Gum arabic, benzoin, rosin, turpentine, camphor, essential oils, coco-nut oil, palm oil, other

fixed oils, caoutchouc, gutta pertsha.

12. Substances obtained from the vegetable kingdom and used as medicines.—Opium, quinine, tobacco, jalap, scammony, gentian, aloes, rhubarb, senna, ipecacuanha, sarsaparilla, castor-oil, assafœtida,

myrrh, nux vomica, hemlock.

Text-books for Vegetable Physiology and Economic Botany.—Henfrey's Elementary Course of Botany; Van Voorst. Carpenter's Vegetable Physiology, edited by Dr. Lankester; Bohn. Schleiden's Principles of Scientific Botany; Bohn. A Manual of Structural Botany by M. C. Cooke. Archer's Popular Economic Botany; Reeve and Co. Lindley's Medical and Œconomical Botany; Bradbury and Evans.

Subject XVII.—Systematic Botany.

In this department the candidate will be expected to demonstrate the

structure of plants from living specimens.

1. The distinctions between the three great classes of plants, Dicotyledons, Monocotyledons, and Acotyledons. Also of the groups Gymnosperms, Rhizanths, Dictyogens, Acrogens, and Thallogens.

2. The characters of the following orders of British plants should be mastered, and the typical genera recognized, and their structure

understood.

3. Algæ. The natural history and uses of sea-weeds. The microscopic structure of diatoms and desmids. Nature of the reproductive organs in this order. Types—Navicula, Desmidium, Conferva, Fucus,

4. Lichens. The natural history and uses of lichens. Structure of their

reproductive organs. Types-Graphis, Collema, Parmelia.

5. Fungi. The natural history of mushrooms, puff-balls, moulds, blights, and toadstools. Their uses in nature. Types—Agaricus, Bovista, Torula, Aspergillus, Morchella, Mucor.

6. Mosses. The nature of their reproductive organs. Types - Bryum,

Sphagnum, Funaria.

7. Ferns. Nature of their rhizomes. Herbaceous and tree ferns. History of Development, and nature of reproductive organs. Types

- Polypodium, Hymenophyllum, Osmunda.

8. Graminaceæ. The history of grasses and their uses. Nature of the flower in this order. Useful plants of the order. Types—Phleum, Hydrochloa, Panicum, Agrostis, Arundo, Spartina, Avena, Festuca, Hordeum, Triticum, Secale, Nardus, Anatherum.

 Cyperaceæ. Sedges. Types—Carex, Scirpus.
 Liliaceæ. The lily tribe, its useful properties. Types—Tulipa, 10. Liliaceæ. Ornithogalum, Muscari.

11. Amaryllidaceæ. The family of the narcissus, snow-drop, snow-flake. Types—Narcissus, Galanthus.

12. Orchidaceæ. The orchis family. Structure of reproductive organs.

Types—Orchis, Goodyera, Malaxis, Cypripedium.

13. Amentaceæ. The family of the hazel, chestnut, oak, willow, birch, beech, poplar, and hornbeam. The uses of these plants as timber, &c. Types—Quercus, Corylus, Fagus, Castanea, Betula, Myrica, Salix, Populus.

14. Urticaceæ. The nettle and hop tribe. Its relations to Moraceæ, Artocarpacæ, Cannabinaceæ, and Ulmaceæ. The nature of the stings of Urtica, and the bitter principle of the hop. Types—Urtica,

Parietaria, Humulus.

15. Euphorbiaceæ. The spurge family. Foreign forms and their uses. Croton, Cascarilla, Ricinus, Janipha. Apetalous and Polypetalous forms. Types—Euphorbia, Buxus.

Polygonaceæ. The buckwheat and rhubarb tribe. Types—Poly-

Polygonaceæ.

gonum, Rumex.

17. Primulaceæ. The primrose family. Theory of the peculiar position of stamens. Types—Primula, Lysimachia.

18. Labiatæ. The dead nettle tribe. Peculiar properties of this order. Types-Mentha, Salvia, Thymus, Nepeta, Lamium, Teucrium.

19. Scrophulariaceæ. The scrophularia tribe. Nature of the poisonous properties of the order. Types—Scrophularia, Digitalis, Verbascum, Euphrasia, Veronica, Melampyrum.

The borage tribe. Peculiarities of their epidermis. 20. Boraginaceæ. Useful species. Types—Cynoglossum, Borago, Echium, Myosotis

Lithospermum.

21. Solanacea. The tribe of deadly nightshade, henbane, tobacco, and potato. Useful and poisonous species. Types—Solanum, Atropa, Hyoscyamus, Datura. Digitized by \$100gle The heath tribe. Its distinction from Epacridacea.

Types-Erica, Arbutus, Vaccinium, Pyrola, Monotropa.

23. Compositæ. The composite family. The number of species and geographical distribution. Structure of the sub-orders Asteracea. Cichoracea, and Cynaracea. Types-Tussilago, Aster, Inula, Gnaphalium, Bellis, Artemisia, Achillea, Carlina, Carduus, Cichorium, Leontodon, Lactuca, Crepis. Stellatæ. 'The Stellate tribe.

24. Stellatæ. Its relation to Cinchonaceæ and Caprifoliaceæ. The properties and useful plants of Cinchonaceæ.

Types--- Galium, Rubia.

25. Umbelliferæ. Umbel bearing plants. Character of inflorescence and flowers. Nature of fruit. Structure of cremocarp. Properties of the order. Types-Hydrocotyle, Sanicula, Eryngium, Apium, Sium, Æthusa, Œnanthe, Crithmum, Angelica, Pastinaca, Daucus, Torilis, Scandix. Conium, Coriandrum.

26. Cucurbitace. Melon, cucumber, and gourd family. Useful plants of this order. Type—Bryonia.

27. Rosaceæ. The rose, apple, cherry, and plum tribe. Forms of the fruit. The useful plants of this order. Types-Prunus, Spiraa,

Fragaria, Rubus, Geum, Rosa, Cratægus, Pyrus.

28. Leguminosæ. The bean, pea, and clover family. Principal divisions of the family. Structure of the flowers and fruits. plants of the order. Types—Ulex, Trifolium, Vicia, Astragalus, Ornithopus.

29. Crucifera. Cabbage, turnip, and mustard tribe. Structure of the flowers and fruits. Useful plants of the order. Properties. Types-Nasturtium, Alliaria, Brassica, Sinapis, Armoracia, Iberis, Isatis,

Crambe, Cakile.

30. Papaveraceæ. 'The poppy tribe. Properties and mode of collecting opium. Nature of fruit. Types—Papaver, Glaucium, Chelidonium.

31. Ranunculacea. The crow-foot tribe. Structure of abnormal genera; Aconitum, Aquilegia, and Delphinium. Nature of poison in order. Types—Rununculus, Clematis, Helleborus, Pæcnia, Anemone.

Text-books for Systematic Botany.—Lindley's Vegetable Kingdom. For British Botany.—Bentham's Handbook of the British Flora, or Babington's Manual of British Botany.

Subject XVIII.—Mining.

The Art of Mining embraces so wide a field of study that equal practical proficiency in its various branches is not to be expected; but those who wish to gain a general knowledge of it may be recommended to

direct their attention to the subjoined heads, viz. :

1. Geology and Mineralogy, more particularly those portions of the sciences which bear on the following subjects,—the nature and position in the earth's crust of the useful minerals, the classes of rock with which they are severally associated, the special character of heaves, throws, troubles, and all kinds of dislocation; the particular differences between beds and lodes, and their minerals, and the chief features of irregular repositories.

2. The methods of prospecting and searching at surface for ores and

other minerals.

3. Breaking of ground; the various implements employed, their form, dimensions, and weight; boring for shots; the various modes of firing charges. Heavy charges, how calculated and fired; rules for ensuring safety.

4. Deep boring, under what circumstances applicable,—apparatus for;

description of varieties in use; lining of bore-holes.

Management and supervision; payment of men employed at mines. at surface and underground, varying in principle with the different classes of operation; reasons for tut-work or piece-work, and tribute or bing-tale under different circumstances. Calculations for cost of driving,

sinking, tramming, &c.

6. Physical principles of ventilation; practice of mines where simple natural ventilation is employed; ventilation of large areas and of deep or complicated workings by guiding the natural current; artificial means, and their details, for promoting ventilation. Precautions to be taken under specially dangerous conditions.

7. Illumination, of various kinds, their economy; safety lamps in all their best modifications; circumstances under which they should be

employed; precautions in their use.

8. Mechanical division of the subject. Strength of materials used in mines; human and horse power, principles and construction of machines to which they are applied. Hydraulic machines: construction of the water-wheels, turbines, and pressure engines most suitable to the various operations of mining. Steam engines, for pumping and for winding; arrangement and construction of the varieties most in use. Form and dimensions of boilers. Pumps employed in mines, mode of placing them; construction of the lifts; materials and details of the rods, setoffs, counterbalances, cisterns, and catches. Circumstances under which dams are erected in shafts or levels; mode of building them.

Tubbing of water from shafts; conditions under which it may be done; details of the operation with various materials, wood, brick, stone,

cast and wrought iron.

Rails, waggons, and tubs for underground conveyance; employment

of horses and of fixed steam engines for this purpose.

Raising of the mineral through the shafts; various methods in use; chains, ropes (of hemp or wire), their weight, &c. Details of the best application of drums, cages, guides, keeps, and safety doors. Pulleys and shaft frames or poppet heads; protection against over-winding; safety clutches, &c. in case of breakage of rope.

9. Opening of ground; quarries and open work; driving of levels, various dimensions and directions according to circumstances; sinking of shafts, inclined or perpendicular; advantages of either kind under certain conditions; means of securing levels and shafts by timber or by walling; details of the various methods. Driving or sinking in heavy

or running ground.

10. Working excavations; plan of laying them out, and means of security to be adopted whilst they are kept open. This will include the stoping of metalliferous veins, and the various modifications of post and stall, long-work, &c., which are applied to stratified deposits.

11. Travelling in shafts; prevention of accidents by proper fitting and dividing; mode of placing ladders and sollars; lifting machine for men,

. construction and advantages of.

12. Dressing of minerals. Arrangement of dressing floors. Construction of crusher and stamps; washing of coal; jigging, concentration, and separation of metallic minerals.

The student may be advised among other sources of information to

consult the following works :-

De la Beche's Report on Cornwall and Devon. Greenwell's Treatise on Mine-Engineering. Dunn on the Winning and Working of Collieries. Hedley on Colliery Working and Ventilation. Evidence before Committees of the Houses of Lords and Commons on Accidents in Mines. Reports of H.M. Inspectors of Coal Mines. Transactions of the Northern Institute of Mining Engineers.

Subject XIX .- Metallurgy.

I. Introduction.

On certain physical properties of metals. Action of heat, specific gravity, crystallization, fracture, malleability, ductility, tenacity, con-

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ductivity of heat and electricity, opacity, lustre, colour. General considerations on metallurgical processes. Modes of occurrence of metals in nature, ores, reduction, smelting, roasting, liquation, slags.

II. Fuel.

General remarks, calorific power, calorific intensity, classification of fuels, wood, peat, lignite, coal, charcoal, coke, gaseous fuel and gas furnaces, charcoal burning, coke burning, typical varieties of coke ovens, comparison of fuels with respect to calorific power. This important branch of the subject is treated with much detail.

III. Refractory materials employed in the construction of furnaces, crucibles, &c.

Fire-clays British and foreign, crucibles of various kinds, plumbago and its application to crucibles, manufacture of crucibles, fire-bricks, silica and its applications, Dinas fire-bricks, sand and sandstones.

IV. Special Metallurgy.

Copper.—Compounds of special importance in the metallurgy of this metal fully described, such as the disulphide, oxides, &c., ores of copper, copper-smelting in reverberatory and blast furnaces, reactions occurring in the process, kernel-roasting, 'wet' methods, of extracting copper from its ores, assaying of copper ores by 'dry' and 'wet' methods,

ship sheathing.

Zinc.—In describing the metallurgy of zinc and the following metals, the same plan will be followed as in describing the metallurgy of copper, that is to say, the compounds of special metallurgical importance will be first considered in detail, as well as the reactions upon which the various processes of smelting essentially depend, and the construction of the furnaces will be fully explained. Ores of zinc, English, Belgian, Silesian, and Carinthian methods of extraction, assaying of zinc ores brass, its history, properties and manufacture.

Lead.—Ores of lead, lead smelting in the 'ore-hearth,' low blast and reverberatory furnaces, lead-fume and various methods adopted for its

condensation, assaying of lead ores.

Silver.—Ores of silver; smelting of silver ores with lead; cupellation; desilverization of lead by Pattinson's process, also by that of Parkes; treatment of argentiferous copper by liquation; extraction of silver; amalgamation, the old Freiberg method and the Mexican; Ziervogel and Augustin's 'wet' methods; treatment of argentiferous copper-regulus; alloys of silver and copper; standard silver; assaying of silver ores and alloys.

Gold.—Modes of occurrence of gold in nature; extraction by amalgamation and by smelting with lead; chlorine-water as a solvent for the extraction of gold from certain ores; separation of gold from silver or parting by nitrie and by sulphuric acids; alloys of gold with the preceding metals; standard alloys; assaying of auriferous ores and

alloys.

Mercury.—Ores of mercury; extraction in the Almaden, Idrian, and Hähner furnaces; in retorts in admixture with reducing agents; assaying

of the ores of mercury.

Antimony.—Ores of antimony; liquation of the native sulphide and its subsequent reduction by iron or other agents; alloys of antimony, type metal, &c.; assaying of the ores of antimony.

Bismuth.—Mode of occurrence in nature; its extraction from ores

containing it by liquation; alloys of bismuth.

Nickel.—Ores of Nickel; modes of extraction, generally by a com-

bination of 'dry' and 'wet' processes; alloys of nickel, especially those known as German silver; assaying of nickeliferous ores and alloys.

Cobalt.—Ores of cobalt; smelting and preparation of zaffre and cobalt colours, smalts, &c.; separation of nickel; assaying of cobalt

Arsenic.—Mode of occurrence in nature; arsenious acid or 'glass' of arsenic, generally obtained as a secondary product in the treatment of certain other ores, such as those of nickel, cobalt, &c.; modes of condensation of arsenical fumes; preparations of arsenical 'glass,'

Tin.—Ores of tin; smelting in reverberatory and blast furnaces; tin refining; varieties of tin in commerce; alloys of tin, with the preceding metals, bronze, gun-metal, bell-metal, &c.; assaying of tin-ores.

Iron.—Malleable iron; steel; pig-iron; ores of iron, direct extraction of iron in the malleable state from the ore; smelting of iron in the modern-blast furnace; construction of blast-furnaces and blowing machines; economic application of the waste gases; conversion of pig into bar iron in open hearths and in the reverberatory furnace; manufacture of steel by various methods. This department of the subject will be treated at considerable length.

Various Metals.—Platinum and its associated metals; cadmium;

sodium; aluminium; tungsten; titanium; manganese.

Subject XX.—Navigation.

 Elementary Principles.—Problems relating to latitude, longitude; differences of latitude, and differences of longitude.

Relation between an arc of a parallel of latitude and an arc of the equator. Principles of plane sailing and middle latitude sailing. Principles of Mercator's sailing. Mercator's chart. Principles of great circle sailing. The compass and its corrections.

great circle sailing. The compass and its corrections.

(1.) Variation. (2.) Deviation. (3.) Local attraction. (4.) General theory of deviation (Towson's Practical Information, first 50 articles). Correction of courses for variation, deviation, and leeway. The log. Correction of estimated distances run for errors in the log line and glass. Plane sailing. Traverse sailing. Middle latitude sailing. Mercator's sailing, with examples.

To find difference of longitude made on a traverse. Sea journal. A day's work. Practice of great circle sailing. Circular arc sailing. Tides. Winds. Cyclones. To find bearing of a circular storm; veering of wind; heaving to; and sailing from centre of gale.

Construction of tables of meridional parts.

Description and use of sextant, with the theory, adjustments, and errors.

Note.—Candidates for certificates as teachers of Navigation will be required to possess a competent knowledge of the whole of the above syllabus, and to have obtained a certificate in elementary mathematics and passed in higher mathematics as far as spherical trigonometry inclusive.

For students.—To "pass," as far as principles of plane sailing. The

compass and correction of courses.

For honourable mention.—As far as Mercator's sailing, with examples. For third, second, and first class Queen's prizes, a proportionate knowledge of the remainder.

Subject XXI.—Nautical Astronomy.

Definitions. Time, apparent, mean, sidereal, &c. Equation of time. To express interval of mean or sidereal time in parts of sidereal or mean time respectively. To convert arc into time, and conversely. To find Greenwich date. To take out right ascension of sun for a given mean Greenwich date.

Correction of altitudes. Dip. Parallax. Refraction. Augmentation of moon's semi-diameter. Reduction of altitude of a heavenly body observed at one place to what it would have been if observed at another. The chronometer and its use, error, and rate.

Latitude by meridian altitude of sun, and fixed star.

Latitude by meridian altitude of moon. To find Greenwich mean time of moon's meridian passage. To find semidiameter and horizontal parallax of moon for a given Greenwich date. To take out from

Nautical Almanac moon's declination, &c.

To find local and Greenwich mean time of passage of a star over a given meridian on a given day. Latitude by altitude of sun, star, or moon below the pole and by pole star. Latitude by altitude of sun or other heavenly body near the meridian. Calculations of hour angles. Meridian distances. Right ascensions. Computations of time. Error and rate of chronometer. Computation of mean or apparent time at any place from observed altitude of a heavenly body. Longitude by chronometer. Error in hour angle from error in observed altitude. Variation of compass. Azimuth, altitudes, amplitudes, determination of true bearings. True azimuth from altitude of heavenly body and without observed altitude. True bearing of a point of land, &c., by observed angular distance from the sun. Variation of compass from observed amplitude of sun.

Deviation of compass, from Art. 50 to end of Towson's Practical Information. Sumner's method of finding longitude and latitude.

Method of double altitudes, Ivory's and direct. Error of chronometer by equal altitudes of sun and fixed star. To compute apparent

altitude of a heavenly body when its true altitude is given.

Methods of clearing a lunar distance from the effects of parallax and refraction. To find Greenwich date corresponding to a given true lunar distance, &c. To find the altitudes when a lunar distance is taken from altitudes before and after taking the distance. To find the longitude by a lunar. Rate of chronometer by a lunar.

Obs.—In all the above problems the demonstration of the rules as

well as accurate practical working is required.

NOTE.—Candidates for certificates as teachers will be required to possess a competent knowledge of all the above syllabus, and to have obtained a certificate in the elementary mathematics, and passed in higher mathematics as far as spherical trigonometry inclusive.

For students.—To "pass," a knowledge of the elementary principles,

and finding latitude by meridian altitudes of a heavenly body.

For "honourable mention," the above, with variation of compass from altitudes and azimuths, and rate of chronometer, and longitude by chronometer, is required.

For third, second, and first class Queen's prizes, a more or less accurate

knowledge of the remainder.

Subject XXII.—Steam.

1. General Properties of Steam.—General effects of heat and cold, with practical applications of the principle. Law of expansion by heat not universal. Beneficial result of this anomaly. To ascertain the temperature of any substance. Pyrometer. Thermometer—Description—Graduation. Comparison of thermometers when differently graduated. Laws of cooling. Conduction. Conducting powers of bodies. Convection. Explanation of some natural phenomena by this law. Radiation. Radiating power of bodies. On what it depends. Land and sea breezes. Capacity for heat. Unit of caloric. Latent

heat. Under what circumstances heat becomes latent. Heat sole agent in melting and vaporising bodies. Calorimeter. Sources of heat. Combustion. Temperature necessary for it. Boiling point. Temperature of elastic fluids. Vapour. Formation of dew. Distinction between vapour and steam. Boiling points of fresh and salt water. Distillation. High-pressure steam. Measure of steam by atmospheres. Steam when in contact and when not in contact with boiling water. Relation between pressure, density, and temperature of steam. Specific gravity of steam. Common, superheated and surcharged steam. Priming. Analysis of sea water.

 Steam Engine.—General principles. Different kinds. Engines in use before Watt. Newcomen's engine. Its defects. Discoveries of Watt. Blowing through. Defects in atmospheric engines. Single acting and double acting engines. Expansion valve. Cornish-High-pressure or non-condensing engine. Marine steam engine. Different descriptions. Side-lever marine engine. Blow-valve. Stuffing boxes. Piston of steam cylinder. Working parts. Working of the slides, strap, gib, and cutter. Escape valve of cylinder. Parallel motion. Hall's condensers. Test cocks. Grease cocks. Grease cups of slides. Annular air-pump bucket. Annular delivery valve. Various kinds of slides. Cushioning, Lead. Lap, its effects. The eccentric. Throw and stops of ditto. To find the travel of the slide. Back-lash. Double eccentric. Throttle valve. Expansion valve and various kinds. Barometer or condenser Method of estimating pressure by it. Errors in this method, and correction of the same. Lubricators, &c. Number of engines in a steamer. Expansion cams and gear. Feed pumps. Bilge pumps. Modes of propulsion. Paddle wheels. Pitch, Reefing. Disconnexion and immersion of wheels. Brakes.-Modes of fitting. The screw propeller. Length, angle, pitch, slip, area of screw Disconnecting and raising screw. Governors. Direct blade. acting engines. Gorgon-Fairbairn's double cylinder, oscillating, trunk engines, &c. Engines for screw propellers. Direct acting, with and without multiplying gear. Oscillating horizontal and trunk engines. Double acting air-pump.

3. Boilers.—Description. Gear connected with them. Tubular boiler. Number of boilers. Steam chest. Safety valve. Waste. Steam funnel and drip pipe to steam gauge. Wash or dash plates. The funnel dampers. Reverse valve. Communication or stop valve. Blow-out cocks. Circulating pipes. Brine pumps. Brine valves.

Refrigerators.

4. Calculations.—Methods of measuring efficiency of steam engines. Duty of an engine. Horse power. Mercantile or nominal horse power. Horse power from the evaporation in the boiler. De Pambour's theory. Velocity of maximum useful effect. To find evaporation of a condensing engine of given dimensions and horse power, the piston moving with a given velocity with and without expansion. To find the pressure in cylinder, knowing the effective evaporation. To find the diameter of a cylinder to work at a certain speed, knowing the evaporation. To find the evaporation in the boiler, knowing the diameter and velocity of piston and pressure of steam in the cylinder with and without expansion. Same for locomotive, Watt's engines, &c.

The screw—to find its area. Angle of the helix or thread of the screw propeller—to find the pitch. The power exerted by a screw. How far slip depends on form and dimensions of the screw. Motion of paddle-wheels, &c. Consumption of fuel. Measure of locomotive performance of marine steam engines. To find the angle the

crank has moved through when the piston is at a given distance from the top of the stroke. Amount of work developed by crank in a half-revolution—length of radius-bar in side lever engine. Work done in the up and down stroke of the air pump. The best temperature for the condenser of a steam engine. Qualities of fuel, &c.

5. Practical working.—Getting up steam. Mode of starting. Working engines at moorings. Priming—causes and remedies. Banking up and putting back fires, &c. Duties to machinery when under steam, boiler, fires, &c. Injection pipes. Kingston's valves. Leaks in engines. Bearings of engines. Expansive working. Management of fuel. Damages and repairs to boiler, &c., after accidents. Duties to engine, &c., on arriving in harbour.

6. Indicator.—The ends it fulfils. Description. Atmospheric line. Method of taking a diagram. The general configuration of diagram to be expected under various circumstances. The slide-diagram. Examination of Indicator-diagram when steam is throttled; when expansive gear alone used, and in other cases. To ascertain the horse-power of an engine by means of the indicator. To find quantity of water evaporated. Friction of steam engine without load. Diagram when there is no condensation. Diagram showing the relative motions of slide and piston at every point of the stroke.

Dynamometer. To find horse-power of engine by means of it.

The text books specially recommended are—The Marine Steam Engine, by Professor Main and Mr. Brown, R.N., Longmans and Co.; Main and Brown's Indicator and Dynamometer; De Pambour's Theory of the Steam Engine.

Note.—No certificate as a teacher of steam will be given unless the candidate has obtained a certificate in elementary mathematics and theoretical mechanics; and no first grade certificate, unless he has taken a certificate in higher mathematics.

Subject XXIII .- Physical Geography.

The knowledge included in this subject embraces:—

a. A general acquaintance with astronomy, so far as it relates to terrestrial phenomena.

b. Distribution of the land and water; forms of the great continents; the general structure of land with regard to mountains, table lands, plains, deserts, islands, &c.

c. The ocean; its physical and chemical characters, temperature, depth, waves, tides, tidal bore, progress of the tide wave, ocean currents, and soundings.

d. Inland waters, including the phenomena of springs, rivers, lakes, and influence of the distribution of inland waters upon com-

e. Winds, including land and sea breezes, trade winds, variable winds, law of storms, cyclones, &c.

f. Climate: physical causes which determine climate, isothermal lines, and temperature tables.

g. Distribution of plants and animals, especially as their produce is turned into articles of commerce; and classification of the races of man.

h. Information on the physical geography of the British and Colonial Empire of Great Britain, with especial reference to exports and imports.

SCIENCE FORM, No. 232.

CIRCULAR MEMORANDUM TO SCIENCE SCHOOLS AND CLASSES.

By the advice of the Examiners in Science, the Lords of the Committee of Council on Education have sanctioned the following rules for the examination of Science Schools and Classes in May:—

- 1. That there shall be two examination papers in each subject; one of which (the first) will be an easy paper, the other (the second) more difficult.
- 2. That the candidate shall be allowed to select questions out of either the first or the second paper; but not out of both.
- 3. That the candidate shall be restricted to a certain number of questions in each paper—the number which he may fairly answer in the time allowed—and that the paper shall consist of about half as many more questions. Thus, if eight questions in a paper can fairly be answered in the three hours, the paper will consist of about twelve questions, and the candidate will be allowed to attempt any eight of those, but no more.
- 4. That the 5th and 4th class shall be obtained from the first paper only, and the 1st and 2nd class from the second paper only; whilst the 3rd class may be obtained from either the first or the second paper.

Thus, for instance, if the candidate is restricted to eight questions in the first paper and to ten in the second paper in a subject, then the number of marks attached to some eight and some ten of those questions respectively will be 100, and 40, 60, and 80 * marks in the first paper will give a 5th, 4th, or 3rd class respectively, while 40, 60, and 80 marks in the second or difficult paper will give a 3rd, 2nd, or 1st class. The 3rd class will thus be obtained either by very good answering in the easy paper or by fair answering in the difficult.

5. Teachers are recommended to explain the system fully to their pupils before they come up to examination, and, if possible, from their knowledge of the students' attainments, to advise them which paper to attempt.

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^{*} These per-centages are only given as examples. The scale may vary from time to time.

LIST of SCIENCE SCHOOLS and CLASSES, showing the NUMBER of STUDENTS under Instruction in 1865-66, and NUMBER of Medals and Prizes obtained.

Town. Where held, Chairman, Secretary. Toacher. Institutends State 1864-6 1864												
Rechanics Institution Rateliffe, Wm. Slater, James K. 21 21 22 23 24 24 24 24 24 24		Where held	Chairman	Rocretare	Tyacher	Numb Individud	er of luads			umber Prizes		Number of Medals.
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Independent Methodists Winterburn, Geo. Vickers, James Collins, J.	•			Lowe, Rev. J.	Mellor, James Spriggs, C.	: 2	3 28				: :	
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Diocesan Trade School The Rev. Canon Wilkson, John John Judone, A. Townley Briggs, Benjamin Gunn, W. Strike, C. Townley Parker, A. Townley Wilkson, John Gunn, W. Strike, C. Toknop, W. Strike, C. Townley W. Strike, C. Tow	•	School. Holy Trinity Working Men's Institution.	Hick, John		Collins, J	2	2				:	:
Church of England Literary Parker, A. Townley Briggs, Benjamin Schore, T. W. Striker, W. Briker, W. Striker, W. St	•	•		Wilkson, John -	Leipner, A	120	021				:	~~ 4 % 6 % W
Butterworth, Healey, Thomas 19 19		Church of England Literary Institute.	Parker, A. Townley	Briggs, Benjamin	Shore, T. W.	55					:	10
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Bury - Gurlion Road School - Shutileworth, Sir Sutherland, J. Gurn, William School - Hassey, J Gurnent, W.T Gurnent, W.T School - Hassey, J Gurnent, Leonard School - Gradinis Hanry Cheetham Hill Wesheard Dry School - Downing, James - Milliouse, Joseph Karyon, B. D
Bury - Gurlion Road School - Shutileworth, Sir Sutherland, J. Squim, William B. Bury - Gammas School - Hars, St. Sutherland, J. Squim, W. Bury - Mechanics Institution Highward, O. F. Comera, J. Comera, J. Bury - Athenseum - Highward, O. F. Comera, J. Squim, W. Bury - Athenseum - Highward, O. F. Pomtret, Joseph Rodge, C. Cheetham Hill, Wesleyan De School - Downing, James - Milliouse, Joseph Ronyon, B. D. Cheetham Hill, Wesleyan De School - Downing, James - Milliouse, Joseph Ronyon, B. D. Cheetham Hill, Wesleyan De School - Downing, James - Milliouse, Joseph Ronyon, B. D. Cheetham Hill, Wesleyan De School - Downing, James - Milliouse, Joseph Ronyon, B. D. Cheetham Hill, Wesleyan De School - Downing, James - Milliouse, Joseph Ronyon, B. D. Cheetham Hill, Wesleyan De School - Downing, James - Milliouse, Joseph Ronyon, B. D. Cheetham Hill, Wesleyan De School - Downing, James - Milliouse, Joseph Ronyon, B. D. Cheetham Hill, Wesleyan De School - Downing, James - Milliouse, Joseph Ronyon, B. D. Cheetham Hill, Wesleyan De School - Downing, James - Milliouse, Joseph St. Cheetham Hill, Wesleyan De School - Downing, James - Milliouse, Joseph St. Cheetham Hill, Wesleyan De School - Downing, James - Milliouse, Joseph St. Cheetham Hill, Wesleyan De School - Downing, James - Milliouse, Joseph St. Bastington - Returnsition - Christy, Richard - Black Debrer, J. T. Pullion, Million, Debrer, J. Bastington - National Schoolroom - Petera, Rev. Thomas - Websier, Thomas - Hilliam - Websier, Rev. H. Ballikar - Working Men's Institution - Chaloner, Thomas - Websier, Thomas - Websier, Thomas - Websier, Thomas - Hilliam - Websier, Rev. H. Bayden - Mechanics' Institution - Chaloner, Thomas - Websier, Thomas - Websier, Thomas - Milliam - Milliam - Milliam - Mi
Carlion Road School Maclure, Rev. E. C. Greenwood, David Sim, William School Maclure, Rev. E. C. Greenwood, David Sim, William T. Weekele School Machine Institution Machine M
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Bury - Garlton Road School - Shuttiloworth, Sir Sutherland, J. J. Kasery, L Massey, J Mechanics' Institution - J. Kasery, L Massey, J Massey, J Hildrard, C. F Pomfret, Joseph Cardiff - Sheelen Day School - Downing, James - Mechanics' Institution - Hollewark, Robert - Mechanics' Institution - Downing, James - Mechanics' Institution - Christy, Richard - Blackburn, James Doylsden - Ilterary Society Head, R. T Tucker, J. R Tucker, J. T Raimouth - National School Head, R. T Tucker, J. T Raimouth - Mechanics' Institution - Charles, Rovier, Rev. Hooges, S Gloucester - Ilterary Institution - Waghbourn, Bu. Fowier, Rev. Hodges, S Gloucester - Blue-coat School - During, P Tucker, J. T Halla, James - Webster, Thomas Hallax Working Men's Institution - Thompson, Royt Binith, Bert. William Working Men's Institution - Thompson, Royt Binith, Bert. William Working Men's Institution - Reimers, Francis T. Wilson, Edward - Blunderfield Working Men's Institution - Reimers, Francis T. Wilson, Edward - Hull Working Men's Institution - Reimers, Francis T. Wilson, Edward - Burbert, Edward - Lawton, Thomas - Ghool Residency Mederfield Working Men's Institution - Reimers, Francis T. Wilson, Edward - Lawton, Thomas
Grammar School Shuttleworth, Sir Grammar School Shuttleworth, Sir Sutherland, J.
Bury - Garlton Road School - Hasting Roy, E. C. Gardiff - Grammar School - Hassey, I Hechanics' Institution - Hassey, I Hechanics' Institution - Hasting, W. B. Birred. Cheetham Hill. Wesleyan Dey School - Downing, James Mechanics' Institution - Problem, James Mechanics' Institution - Problem, James Mechanics' Institution - Holloway, I. B. Mechanics' Institution - Christy, Biobert Crewe Mechanics' Institution - Ramsbocham, James Mechanics' Institution - Christy, Biobert Grewe Mechanics' Institution - Christy, Biobert Mechanics' Institution - Christy, Biobert Rastington - National Schoolroom - Peters, Rev. Thomas Exeter Literary Society Head, B. T Falmouth National Schoolroom - Peters, Rev. Thomas Greenwich - Literary Institution - Chaloner, Thomas Hasiliax Working Men's Institution - Chaloner, Thomas Haddersheld - Mechanics' Institution - Chaloner, Thomas Haddersheld - Mechanics' Institution - Chaloner, Thomas Huldersheld - Mechanics' Institution - Reimers, Francis Huldersheld - Mechanics' Institution - Reimers, Francis Hulme Ghrist Church School - Gaskill, J Hyde Hechanics' Institution - Reimers, Francis - Hulme Hechanics' Institution - Heibert, Refward - Hulme Hechanics' Institution - Heibert, Refward - Hyde Hechanics' Institution - Hyde Hechanics' Institution - Hyde Hechanics' Institution - Hyde Hechanics' Institution - Hyde
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List of Science Schools and Classes, &c.—continued.

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Teacher.		Packer, M. W. Packer, M. W.	Ward, George - Atkins, Edward	Birkenhead, Jones, John	Pike, Robert Simpson, B.	G 6 01	Crowe, William Howard, John -	Tate, Ralph Bithell, Richa	Snelus, G. J. Coles, F.	٠, د	ohn	Alfre J. J.	1, 1, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5,		S. F. F.	. T
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Secretary.	,	Harvey, J. K Bolton, Thomas.	Blaker, Barnett Jones, H. S.	S. I	Rüntz, George Halliday, J.	Waterman, O.	Goslin, John Ross, John	Hoskins, W. H.	Cousens, James	Webb, W. H.	٦,	Brooker, John	Brooker, John Huntington,	Jarrett, Albert -	W.E.	40
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Chairman.		Brinton, John - Wharton, Georg	Oxley, Henry - Vaughan, Rev.	son, C. ₩	þe,	d B	80°83 Magagar	Aveling, Thos.	zie,		Herrick, W. P.	Şev.	Callendar, W.	owker, W	Turner, Wright Gilkes, Edgar - Dumford, Rev. 1	
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		School of Art -	Mechanics' Institution St. Martin's School	Ashwell Street Scho Free Library - Copper Works School	Birkbeck Schools St. Matthew's School	Camden Hall - Working Men's Institution	Parochial School Lower Public School	North London School of Science.	yal]	Sailors' Home	The Institute	Mechanics' Institution	Modern Free School Cathedral Schools	Mechanics' Institution	Corporation Street • Mechanics' Institution National School	1
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Bush, James	Hartley, J. Westherill, Robert	Sissing, W.	Mellor, James -	Rockert, L. C.	Butterworth, J.	Pullen, Moses -	Evers, H. Hearder, J. N. Holmes, T.	Merrifield, John Robotham, W.	{Birkenhead, E. H. } {Dunn, W. J.	Mapp, George Michell, Thomas Schoffeld, J	Hudson, F	Parke, G. H.	Dorrell, John Hudson, W Poster, C. Le Neve . Balmain, W. H Rester C. Le Neve	\sim	Packer, M. W Jones, J	Vick, William - { Pullen, M }	{ Viccars, Thos}
Richards, Thos.,	Evans, George - Moyle, Rev. V. H.	Thurlow, Richard	Walters, Rev. W.	Bailey, Thomas -	Taylor, H	Skinner, J. W.	Саwзе, Ј. Н. М	Cumming, W. B. Spickett, E. C.	Dunn, James -	Milward, V. Grylls, W. M Ellis, Robt, P	Noar, Wm.	Pickles, J. Hulbert, P. W.	Chapman, J Newton, Edwin B. Hawke, E. H., inn. Alcock, Bev. H. J. Boyns. Richard	Robinson, S	Welch, J. J.	Boucher, Edwin Foster, Wm	Weeks, Caleb -
Lewis, Thos. T.	Taylor, Joshua Pennyman, J. S.	Morse, Francis .	Bamford, John -			Gardner, W.	Norrington, Chas (the Mayor.)	Hill, R	Wilson, Thomas	Fessey, Rev. Geo. F. Manley, Rev. W. L.	Turner, Wright	Dean, Dr Hulbert, Rev. C. A.	Cree, Rev. J. A Marsland, John Mocatta, Rev. W. A.	Barr, W.R. (the Mayor)	; ; ;	White, Kev. W. F Dickinson, S	Vivian, Edward
Me	Mechanics' Institution -	Mechanics' Institution -	Parish Church School	Science and Art School	Analytical Institution -	Free School Mechanics' Institution -	St. Andrew's Working Men's School.	Navigation School - School Boom, Taff Street	Institution for Diffusion of Useful Knowledge.	National Schools The Institution Literary and Educational Society	Working Men's College	Mechanics' Institution Meeke and Walker's Educa-	Mechanics' Institution Mechanics' Institution Mechanics' Institution Girls' Schoolroom St. Thomas's National School The Institute	stitution .	Grammar School -	The Institution	British School
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Newport -	Newton Heath North Ormesby	Nottingham -	Oldham .	•	•	Painswick - Pendleton -	Plymouth -	Plymouth - Pontypridd -	Preston	Redditch Redruth Roby	Salford	Slaithwaite -	Slough - Staleybridge - St. Day - St. Helen's - St. Just - St. Jus	Stockport -	Stourbridge -	Stonehouse - Strond	Torquay -

Schools established in 1865.

List of Science Schools and Classes, &c.—contraued.

	Where held.	Chairman	Socretary	Teacher	Number of Individuals under			<u> </u>	Number of Prizes.	Numl	Number of Medals.
	•				1864-5. 1865-6.		Incre	Dear	1865.	1864.	1865.
nard's	Upton,St.Leonard's School-room		Betts, Rev. J.	Davis, Urish J.	3	22	-	31 12	1	:	•
Walsall	Christian Institution Mechanics' Institution Mowbray House School	Fergie, Rev. T. F Iles, Bov. J. H.	Ward, Henry - Peace, M. W Langley, J. N	Sutcliffe, Henry Birkenhead, E. H Jones, John	8:88	ដ្ឋ	.: 13 16.	62: 3 10: 3 3: 3	⊣014 €	: :ĕ; :	::::
•	Science and Art Institution	Mumford, A. L.	Meadley, J.	Stone, Win) Burgess, Rev. S	\$	3			2	:	.:
•	Mechanics' Institution,	Anderson, James .	Keeble, W. D	Jones, Thomas	8	28	-:	18	23	63 02	1 B.
•	National School	Brown, Rev. H.	Wilson, James -	Snelus, G. J.	:	ន	<u>:</u>	: -:	•	:	18.
Yarmouth, Great -	Navigation School			Stockton, W.	163			: 3	93	:	:
•	Popular Institution -	Palmer, Rev. H. V.	_	{ Crawley, S }	.: •:	<u>-</u> 8	<u>.</u>	: -	:	:	:
			SCOTLAND.								
-	- Mechanics' Institution -	- Matthews, James -	Sinclair, J.	Braizer, J. S	*	83		ea 		18.	:
:	Navigation School .	•	Kellas, Jas. F.	Jones, J. R.	138	28	<u>.</u>	: :	:	:	:
•	Girls' School .	Sturrock, George	Hourston, S.	Macomish, Margaret	25	31	- :	18	4	:	:
	High School	Sturrock, John	Cumming, A. W.	Kennedy, John	\$	22	.	±0 :	•	18.	:
•	Secular School		Cunliffe, Rich. S.	Mayer, J.	130	021	<u>್</u> ಜ	: :	21	18.	. :
• • •	Athenseum Andersonian			Machattie, Alex. T.	28	25		:: ::	23	:6:	18. gB.
•	New Public School	Aitken, Bev. James	Crawford, Robt.	Stevenson, James >	=	8		:	63	:	. :
•	Navigation School	Lindsay, Wm.	Thomson, Rev.J.	Bolam, James -	234	818	-	18	:	:	<i>:</i>
1.	National School . Literary and Mutual Im-	llowan, Bev. R. W Reilly, James A.	IRELAND. Lynch, Rev. John Black, Robert - Block, Alexander	Black, Robert -	.:	81	18	- <u>:</u>	:-	: :	: :

Belfust	Royal Academical Institute Rosemary Street National	Lyth, John	Nesbitt, R.	MoNelll, James	#.	_ #	Ħ		- a:	·::		::
* *.	School. Great George Street. Model School	Lyth, John	Nesbitt, B. Shepherd, Wm.	Barklie, Robert Smeeth, Rowland	:2	848	ಿ :		::	:: 		::
z ¢		- Patten, James, LL.D.	Moore, G. L. Nesbitt, R.	w ren, Edmond . Doran, George .	8	32	3:	91	_	•		-
Carrickfergua -	Model School	Birnie, T. M.	Nesbitt, R.	Stevenson, J. McN.	8	8	15	· :	_ <u>-</u>	:		:
Comber	Smyth's National School -	Rogers, Rev. John -	Withers, Robt	{ Greer, W. H } { Erwin, M	ដ	88	11	:	-:	: 		:
Drogheda Dublin	Athenseum	- Manning, Joseph -	Crory, W. Glenny	Dowling, John	288	8	٠:	- 69		18 18, 8 B.		m ^m
	Christian Schools		Woodhouse,John	Mayne, Arthur J.	38	20	:	120	::	::		· :
Dundalk .	Free Library	Neville, John	Price, Newton -	{Lyons, M } {Graham, M. M }	••	83	ន	:	:	: 		:
Holywood .		•	;		33				=	:		
Larne	North End National School	McKay, Rev. C. E	Eccles, Wm.	Stevenson, J. McN. }	•:	21	13	:		· :		:
•	Model School		Eccles, Wm.	Hay, Wm.	•:	ន	ន	:	:	: -		:
Newtownards	Model School Model School	Moore, Rev. H.	Osborne, A. T Osborne, A. T	Harbison, M. Greer, W. H.	<u>ಷ</u>	84	28	:	16	: 		:
Oldcastle	- Endowed School .	Dardin, J. G.	O'Neill, Eichard	{Beatty, J }	118	150	a	:	0	: ឆ		å.
Portadown	Thomas Street National	Sherrington, T. A	Appelbe, Rev.	MacMillan, Wm.	•	8	8	:	:	:		:
Portaferry	National School	Filson, Alex. B.	Orr, John -	Begley, Geo. R.	•:	88	83	:	:	:	_	:
Santry		West, The Very Rev. Hackett, Rev.J.W. Mayne, A. J.	Hackett, Rev.J.W.	Маупе, А. J.	8	2	:	83	- :	:		:
Trim Tullamore	The Model School Church Street National	Lightburne, H	Connell, E. A Bradley, J. A	Freehill, M Macgowan, F. M	••••	#8	:8	::	::	::		::
Waterford .	Model School	E. N., Dean of Waterford,	Cewet, James -	Dowling, James	8 	3	:	23	•	:		:
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* Schools established in 1865.

Prosical graphy. : : : :: ; 9 IIIXX : ; **3:::::** ::: ∷೫ :**:**· ::: XXII. .maə48 :: : : : : : :::: :: : :: : TABLE showing the Subjects taught at each Science School, and also the Number of Students in each Subject. .Variou ::: :: : : .IXX : : : ; : : ; :: : :: ; -orteA Nautical tion. : :: : XX :: : :: : : : : : :: : :: : General Naviga-Metallurgy. ::: XIX. :: : : ::::: :::: : :: : .ZainiM XAIII. ::: :: : : ::: :::::: : : : : tany. ::: :: : : :: : : : : : : : XVII. :::: Systematic Vegetable Physi-ology and Eco-nomic Botany. æ ::: ន : : : ::: :::::: : : XAI : : ·VX Z00100Z ::: :: : :ន : ::::: : :: ojo&A• VIX. ::: **z** : : : 28:::3:::8 9 :2 : Pbym-IsminA : 'IIIX Mineralogy. ::: :: : ::::::::: : : : ·IIX Geology. œ :: :: : : **4 : : : : : : :** 16 :8 : Organic Chemis-try. .IX ::: :: : : **8**: : : Inorganic raistry. 128 8 g : 9 :: z : 28 X Magnetism and Electricity. ::: :: : : : 19: : **%**: : : : :ន :ន 'XI Acoustics, Light, and Heat. :: : : : 19: : :: : :ឌ : :: :83 :0 VIII. ENGLAND nics. ::: : : :91 : **ま**: : : : : : : : : : ·IIV Applied Mecha chanica. ::: :: : : : :9 **2**: : ::::: : ·ΙΛ Theoretical Higher Mathe-matics. :: : ::: : : : : : ::: : : : : :: ۰, Elementary M thematics. : : : :: : : ::02 : :::: : :ន ʻΔΙ : Building struction : : **9**: :: : :: : : : : : : : :8 : III. Mechanical and -ward enidaeM :2: :00 : 18 :: ::2: 25 : Π. Geometry :∞ 2: : : 28 : Practical, Plane, and Descriptive : 7: ı. -08 Methodist's Holy Trinity Working Men's Grammar Chancery Lane Educational Church of England Literary Fulledge Weeleyan School Academy Midland Institution Mechanics' Institution Literary Institution Mutual Improvement ciety's Rooms. Mechanics' Institution Mechanics' Institution Mechanics' Institution British School -Mechanics' Institution Mechanics' Institution Bridge Street School -Institute. Diocesan Trade School Where held. Day School-room King James's School. Independent nstitution. Institute. School Ashby-dè-la-Zouch -Ashton-under-Lyne Accrington -Alderley Edge Almondbury Town. Birmingham Blackburn -Bodmin -Andover Ardwick Bacup Banbury Bristol Burnley Bolton 2

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Table showing the Subjects taught at each Science School, &c. -continued.

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Table showing the Subjects taught at each Science School, &c.—continued.

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.xx	General Naviga-	:	:	:::	:	111		::	::	: :	:33	۰:	:
XIX	Metallurgy.	<u>:</u>	:	\$::	:	:		<u>::</u>	::	: :	:::	::	ā
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XVII.	Systematic Bo- tany.	:	:	9 ; :	:	:		::	::	:	:::	::	00
.IVX	Vegetable Physi- ology and Hoo- nomic Botany.	:	:	9::	:	:		::	::	: :	:::	::	· 8
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XIX.	Animal Physi-	81	:	8::	:	_; 		::	::	:	:::	::	:
XIII.	Mineralogy.	:	:	:::	:	:		<u>::</u>	::	:	:::	::	:
,IIX	Georogy.	:	:	:::	:	:		::	::	:	:::	:83	:
'IX	Organic Chemis-	:	:	ន::	:	:		::	::	:	:::	::	2
X.	Inorganic Che- mistry.	:	:	នង :	:	:		::	::	೫	:::	83 :	2
.XI	Magnetism and Electricity.	:	:	:::	:	_:		81:	::	:	:::	:ឆ	:
.TIIY	Acoustics, Light, and Heat.	:	:	:::	:	:	~.	8 :	::	:	:::	::	:
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XXII	Steam.	:	:	:	:	:	:	:	:	:	:	:	:
.IXX	Nautical Astro- nomy.	:	:	:	:	:	:	:	:	:	:	:	· ;
.XX	Navigation.	:	:	:	:	:	:	:	:	:	:	:	:
XIX.	Metallurgy.	:	:	:	:	:	:	:	:	:	:	:	:
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XVII.	Systematic Bo- tany.	:	:	_	:	:		:	:	:	:	:	· :
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XIII.	Mineralogy.	:	:	:	:	-	-	:	_:	:	:	:	:
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TABLE showing Certificates hold by Science Trachers.

Revised by the Examination of November 1865.

	Name. Address.	•	Adookt, Joseph Collegiate Institution, Liverpool Adamson, George Newcastle-on-Tyne Adook, Joseph H. St. Mark's College, Chelsen Allen, Alfred, Edwin Thriming College, Battersea Allen, Alfred H	Allen, Leonard - Allen William - Grammar School, Moulton, near E Allent, James - National School, Raubon, North Almgill, Thomas - Beatley Street, Salford - Mediall, John - Mechanics' Institute, Manchester	Atkins, Edward St. Martin's School, Lowestoft . Atkins, Edward . Atkins, George . Atkins, George .	Bailoy, Edward J. St. Mark's College, Chelsea . Bain, Robert L. Bizabeth Street, Maxwelltown, Dundee	Baker, Bornard M Newport Pratt, County Mayo - Baker, Richmond - Union Workhouse, Witham, Essex Bald, John H St. Buccleuch Street, Glasgow - Baldock John H 14, Claremont Place, North Briton, Lon Bannister, Richard - 7, Coulson Street, Chelses, London	Barklie, Robert - 37, Ship Street, Belfast	
	ctical, Plane,	क्रम्य	iverpool - sea - sea - ld -	on, near Spalding n, North Wales - anchester	l, Lowestoft cester ool, near Shrews-	sea illtown, Dundee	Mayo nam, Essex asgow h Brixton, London	der's, Jersey	
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	Address.	51, Gloucester St., Regent's Park, London Ellacombe, Torquay Queen's Walk, Esling	Science School, Banbury Endowed School, Oldcastle, County Meath 7, Clayton Street, Birkenhead Fore Street, Bodmin St. Paul's School, Tranmere, Birkenhead	b, High Street, Banbury Royal School of Naval Architecture,	Kirkheaton Training College, Battersea 2, Upper Kirkgate, Aberdeen	Mining School, Wigan Orphans' Home, Hailfax National School, Ballymena St. Mark's College, Chelsea	- Portland British School, Riding-house	Training College, Westminster 17, Hon Street, Lower Broughton, Man-	Fraserburgh, N.B. Navigation School, Leith
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Bolt, William P. P. Bonar, David P. P. Bond, Charles S. Boes, Joseph G. Bowing, John P.	Bownler, Arthur C. 18 Bowns, John T. T. Bradbury, Alfred A. T. Bramall, Heary R. Bray, William C. S	Breakwell, William - The Brears, William - The Briggs, Annes Alfred - Briggs, Henry - Street	Bright, William . 17, Brown, Moses . Tre Brown, William J. Tre Bryant, John . St. Burchill, Samuel H. Na	Buckmaster, J. C. Burgess, The Rev. Sml. S. Burns, William Busbridge, Walter Man.	Butterworth, Thomas I Button, John Bystt, Horsco Gard, William F. Cattell, Thomas E N.	Causier, John Wm 12 Chadwick, John 3,	Chalk, Frank • • 3, Olapp, Elizabeth M.A. B

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•	Name.	Clark, Albert Chas. Clement, Leonard Clougn, James C. Cockman, Abraham Coles, Ferdinand	Collins, Frederick O. Collins, John Collins, Joseph H. Conder, John Constable, John	Cook, Charles I., Cook, Thomas H Cooke, Mordecai C Coomber, Thomas - Cooper, Charles -	Cooper, William Corbin, Pennol G. Cork, Charles S. Cover, John L. Cox, George E.	Oraffa, Thomas Oranston, Thomas Craven, Joseph Orawley, Samuel Orlubin, Thomas
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Table showing Certificates held by Science Teachers-continued.

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Crossley, William Crowe, William. Davidson, Blils A. Davidson, George Davis, Uriah J.		Doherty, Joshus J. Doran, George - Dorrell, Charles F. Dorrell, Henry B. Dorrell, John	Douglas, John C. Dowling, James Dowling, John - Downing, Sampson Drew, George C.		D'Urban, Wm. S. M. Durham, Henry Eardley, Francis Easterby, William Eborall, Thomas Edwards, Thomas	Pagar.	Farncomb, Edward - Farncomb, Geo. W Ferguson, W. Hooker Field, William

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		Name,	Finlay, Alex. W. A.	Fords, Robert T. Ford, Benjamin Foister, John S. Foster, Benjamin	Freehill, Michael	Fryar, Mark Fulton, Hugh Gatehouse, James W Gatea, George Gayne, Arthur J.	Gee, William Gelstharp, Charles Gibbs, John Gibson, George H.	Giles, William B.	Gill, James Gledhill, Joseph Goffin, Robert Goodwin, W. H.	Grant, James Grant, William - Greenstroet, Wm.A.
		₽	- 52, India Place, Edinburgh	Banton School, By Denny, N.B. Bolkows Iron Works, Middlesboro' St. Mark's College, Chelsen, London Wesleyan Training College, Horseferry	Model School, Trim -	Andersonian University, Glasgow 22, Brunswick Street, Buston Road Training College, Battersea St. Mark's College, Chelsea	PPAD.	Chemical Laborator	Purleigh, near Maldon,	Hill Top, Burnley - Wesleyan School, Selby
Table showing Certificates held by Science Teachers-continued.		Address.	burgh -	ts, Middlesboro' helsea, London College, Horseferry		sity, Glasgow 7, Buston Road ttersea nelsea	near Manchester - s, Newcastle - nsford - y-de-la-Zouch - Rochester Square,	Campuen Town. Campuen Laboratory, Royal Institute, Menchester	on, Bssex	lby .
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Cowper's House School, Huntingdon	Hodgson, John - Helderoft, Herbert - Holden, John S. Holmes, John - Holmes, John - Holt, George	Training College, Westminster Holywood, Belfärer 94, Parson Street, Glasgow Wesleyan Training College, Westminster	:::::	:::::	:::::	03 : : : :	:::::								:::::	:::::	::09::	: :- : :	:::::	:::::	ea : :ea :	:::••:		
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		Hudson, William Hurst, Edwin	Hutton, David C. Hyslop, Lawrence	Isherwood, Thomas - Ives, William F.	Jackson, Robert Jackson, William Jarmain, George Jeffery, Walter Jenner, William	Johnston, William Johes, Alfred Jones, Edward Jones, Eliz. S. L. Jones, James B.	Jones, John Jones, Richard Jones, Richard	Jones, Thomas .	Judd, John W.
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	Address.	National School, Abertillery, near Newport St. Mark's College, Chelsea	Knighton Street Schools, Leicester Kirk Entry, Wellgate, Dundee Albert Villas, Upper Grey Street, Edin-	Wesleyan Day School, Blackburn St. John's School, Limehouse	St. Mark's College, Cholsea Hunsingore School, Wetherby Bast Parade, Huddersfield Blue-coat Hospital, Gloucester 5, Chesnut Place, Woolwich	The College, Chester 8, Shakespeare Terrace, Stoke Newington Training College, Westminster Yarmouth Navigation School	Rose Hill, Handsworth Copper Works School, Linnelly 8t, Hark's College, Chelses 18, Dundas Terrace, Brookhill Rose, Plum-	stead. 63, Little Peter St., Gaythorn, Manchester	Wesleyen School, Horncastle High Street, Christchurch, Hants
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Kelly, James J. Kennedy, John	Gladsmuir Parish School, East Lothian - School of Art, Dundee	:-	::	::	::	::	::	::	٥٦ :	e :	· :	::	::	<u>::</u>	::	::	<u>::</u>	::	::	::	::	::	::	
Kenyon, Benjamin D.	21, Darlington Street, Cheetham Hill,	:	<u>:</u>	:	<u>:</u>	<u>:</u>	:	:	:	:	စ	:	\div	<u>:</u>	:	:	:	<u>:</u>	Ξ	:	:	:	:	
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Intenford, George . Lee, John . Lee, Robert Leipner, F. J. Adolph Leslie, George J.	St Mark's College, Chelsea- All Sairds' School, Preston- 22, Upper Park Street, Clifton 8, Heriot Place, Edinburgh.	::::: 	::::		ca : : :co	* * * * * * * * * * * * * * * * * * * *	:43 : : :	:::::	:::::	:::::	::::::	::07::	:::::	:::54:	::::	:::57:	:::::	:::::	:::::	67 : : : :	∞ ::::	:::::	:::::	
Lewis, Richard A. Lightbown, James H. Lines, John Lloyd, Willism Longbottom, Josiah	Engineers' Office, Crewe Highlead View, Crossland, Salford St. Mark's College, Chelsea St. Mark's College, Chelsea St. Mark's College, Chelsea Wesleyan College, Westminster	· · · · · ·		:::::	:::::	:::::	:::::	σq ::::	:::::	:::::	: 01 00 01	:07 : : :	:::::	:::::	:::::	::::	:::::	:::::	:::::	:::::	:::::	:::::	::::	
Lumpė, Francis Lyons, Michael McCallum, James McCarthy, Denis Macdonald, William M.	23, Redoliffe Road, London Grammar School, Dundalk Railway Workshops, Kilimarnock Cockrane and Co, Ormeeby Iron Works, Middlesboro'-on-Rees.	::"::			:::-	:::::	:::::	:::::	:eo : : :	;69 : : :	~∞::∞	-::::	:::::	:::::	<u> </u>	:01 : : :	::::	:::::	:::::	:::-:	:::-:	:::::	::::	
McFarlane, Archibald McGowan, Francis M. Machattie, Alex. T McIvor, Alexander - Mackrell, Issac -	Bast Hardwick, Pontefract Model School, Newtownards 1, Stanley Street, Glasgow Wesleyan School, Dartford	:::::			:::::	<u>:::::</u>	:::::	:::::	;∞ ;∽∞	:∞ :⊣∞	::-:09	∞ :- : :	-:::::	:::::	:::::	** ::::	* : : : :	:::::	:::::	:::::	:::::	:::::	:::::	
Macmillan, William - Macmillan, Robert - Macmillan, Edw. H McNeill, James - Macomish, Margaret	Thomas Street School, Portadown District Model School, Sligo National School, Campden 28, Chandos Street, Belfast Corsock, near Dalbeattie	· · · · · ·			:w :w :		:5:::	:03 : : :	:00 : : :	:07 : : :	::03::	:::::	:::::	::::	:00 : : :	•1:::H		:::::	:::::	::::	:::::	::::	~ :::	
McRae, James Madden, Peter Manser, William	Kirtonholm, Kilmarnock • Model School, Carrickfergus Training College, Battersea	*::	8::			<u>:::</u>	<u>:::</u>	۰::	:00:	:-:	::07	:::	:::	:::	<u>:::</u>	:::	:::	:::	:::	:::	:::	eo : :	:::	

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	Adaress.	National School, Redditch British School, Andover	St. Thomas', Charterhouse - Trafalgar, Salisbury 100, Upper Thames Street, E.C. Mechanics' Institute, Aberdeen 50, Gloucester Street, Glasgow	lasgo treet,	Navigation School, Plymouth South Kensington Museum Training College, Westminster Highfield, Greenhill, Oldham	Training College, Battersea 7. London Street, Liverpool St., Mark's College, Chelsea National School, Niton, Isle of	Auchinheath - North End National School, Larne Navigation School, Shadwell
		National School, Reddit British School, Andover	St. Thomas', Charte Trafalgar, Salisbury 100, Upper Thames Mechanics' Institut 50, Gloucester Stree	50, Gloucester Street, G 39, Upper Wellington S 5, George Street, Derby Science School, Oldham St. Mark's College, Chel	Navigation S South Kensin Training Coll Highfield, Gr	Training Coll 7. London Str St. Mark's Co National Sch	Auchinheath North End N Navigation S
·	Name.	Mapp, George Marriott, John T	Marshall, John E. Martin, William Mason, James Maver, David	Mayer, John Mayne, Arthur J Meaden, Henry P Mellor, James Merrick, Edward	Merrifield, John Millard, George G. Milliean, William Mills, Joseph W. Mitchell, Thomas	Moore, Thomas Morris, Mark Morton, George H. Moss, Amos Moyse, John	Muir, Robert Muldoon, Charles Nelson, Robert J
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Table showing Certificates held by Science Teachers-continued.

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Navigation School, Shadwell Navigation School, Well Street	Camborne House, Ventnor- Arsenal School, Woolwich - 15, Salisbury Street, Lisson Grove, London 8, Oxford Street, Chelteniam Fortwilliam, Upton, County Cork	Free Church School, Jamestown, Dumbartonshine. National School, Kinver Wells, Somerset. 10, Mornington Place, Halifax	Trade School, Bristol Kingsbridge, South Devon- Green-coat School, Huntingdon Queenshead Schools, Halifax	Maber Lodge, Portswood, Southampton London Mechanics' Institution South Kensington Museum St. Mark's College, Chelsea 21, Magdalen Street, Exeter	Woothouse Eaves, Loughborough 5, Robert Street, Milford Haven Banbury Birkbeck Schools, Bethnal Green	Trade School, Bristol Royal Museum, Peel Park, Salford 14, Goldington Street, St. Pancras Road	National School, Painswick, Stroud 16. Sheffield Terrace, Campden Hill, Kensington. School of Art. Birmingham	11, Thurlow Villas, West Dulwich
Nelson, B. E Newton, John	Nicholson, William . Noble, John Northey, John Notoutt, William L. O'Keefe, Cornelius .	O'Neill, Charles Orkney, Daniel C. Packer, Matthew W. Palmer, Joseph	Parker, Samuel I. Parkhouse, Henry Pascoe, John Patchett, Isaso Pearce, Biohard	Pearce, William Pearsall, T. J. Peile, Percival B. B. Pepper, Charles Perkins, Frank P.	Perry, George W. Pettitt, William Phillips, Harvey Pidgeon, Daniel Pike, Robert W.	Pitt, Robert Plant, Edmund C. Plant, John Prosser, William Prokett, Joseph	Pullen, Moses Radford, Arthur Raimbach, David W.	Ram, James

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	∆ ddress.	18, Hyde Park Gate South, London Hare Lane, Eaber 16, Dawson Street, Manchester 16, Dewson Street, Manchester 19, Duke Street, Devonport	St. John's Town School, Portsea 2, Oliver Terrace, Oliver St., Nottingtas Training College, Battersea Burpfledd, near Oakley Gwenaap, Redruth, Cornwall	Milton Established Church Sessional School, Glasgow. Bagshot, Surrey Warren Comer, Chondall, Hants School of Mines, Bristol II, Greville Street, E.C.	Spring Grove, London National School, Llanferres, Mold Union Street, Odham Traning College, Ohetenham Birkbeck Schools, Kingsland	Bluecoat School, Wolverhampton II, Victoria Street, Maidenhead Model School, Kilkenny Navigation School, Hull Ashfon-under-Lyme
	Name.	Redgrave, Gilbert E. Rich, Sidney W. Richardson, Henry Richardson, Joseph - Rickard, George J.	Ricks, George Bigg, William . Ripley, Henry J. Rivers, Albert Roberts, John V.	Robertson, John Bobertson, John Bobinson, John Bobotham, William Rossiter, William	Rowden, William Rowland, Evan H. Rückert, Leopold C. Rule, Charles H.	Eashforth, Thomse. East, Joseph . Rynn, Lawrence. Selmon, Wm. R.

Table showing Certificates held by Science Teachers-continued.

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Sammons, Fred. H. C.	11, Devonshire Road, Prince's Park, Liver-	~ ;	- os	: :	-:	÷	<u>:</u>	<u>:</u>	<u>:</u>	:	:	<u>:</u>	÷	<u>:</u>	:	<u>:</u>	<u>:</u>	\equiv	:	:	-:	_:
Samuelson, James Samuelson, Newton Senton, William Sarjeant, John	18, Dale Street, Liverpool 7 and 9, Hackiri Hey, Liverpool Training College, Battersea Church Street, Slough	::::	::::	:::	::::	::::	::::	::::	::::	:∾∾ :	:°° : :	::::	::::		::::	:::::	::::	::::	::::	::::	::::	::::
Saunders, Henry J Saunders, James . Scaping, Zebedee . Schoffeld, Jabez C Schoffeld, John .	Sunderland Ama Street, Luton Navigation School, Trinity House, Hull-St. Mark's College, Chelsen 5, Tipping Street, Ardwick, Manchester	::::61	: : : : 69	:::::	ಇ :⊣ : :	:::::	:::::	:::::	:::::	:::::	:::::	:es : : :	:::::	<u> </u>	:::::		<u>:::::</u>	:::::	٠:٠::	н:н::	::01::	∞ :⊢ : :
Scotson, James Scott, John	247, City Road, Hulme Leieseter Road, Loughborough 18, Cumming Street, Pentonville 60, Huddersfield Road, Oldham Wesleyan College, Westminster	:::::::::::::::::::::::::::::::::::::::	:::::	::::	:::::	::::::	::03::	::00::	:r : : :	:⊣::∞	:::::		* : : : :	63 · · · ·	-::::	:::::	<u>:::::</u>	:::::	:::::	:::::	:::::	: :, : :; :
Sharp, Charles J.	154, Upper North Place, Gray's Inn	:	:	:	:	<u>:</u> :	<u>:</u>	:	:	:	:	÷	:	<u>:</u>		:	<u>:</u>	:	:	:	:	•
Shaw, Henry C. Shawcross, William - Sheaf, Robert Shinn, Thomas -	National School, Falmouth Northwood School, Stoke-on-Trent Queen's Printing Office, B.C.	::::	::::	::::	::::	::::	::::	::::	::::		:00 ;00	::::	::::	<u>::::</u>	::::	::::	::::	::::	::::	::::	::::	:::::::::::::::::::::::::::::::::::::::
Shipman, Charles Shirley, James Shore, Thomas W Simpson, Bentham .	71, Burrage Road, Plumstead St, Mark's College, Ofleisea 45, Ouerden Terrace, Burnley St, Matthew's National School, Bethnal	-:::	∞ :::	:::;	::::	::07:	:::01	::01 64	::0101	:aa :	: : -:	::01 00	:::∞	::::	:: : ::	:::::	::::	::::	::::	:::;:	::::	::::::::::::::::::::::::::::::::::::::
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Slater, James K.	Newton Heath, near Yorkeville, Man-	;	:	:	:	<u>:</u>	<u>:</u>	•••	:	:	:	:	<u>:</u>	÷	:	:	:	:	:	:	:	:
Small, Hugh Smart, Herbert J. Smeeth, Joseph F. Smeeth, Bowland	46, Little May Street, Belfast Liverpool, 1, Fife Terrace, Rathmines, Dublin National Model School, Belfast	: ;0104	::• :	::00:	;r::	::::	::::	::::	r:::	::::	::::	: : : : : : : : : : : : : : : : : : : :	::::	::::	::::	::::	::::	::::	:-:	:-::	::::	;"::
Smith, Joseph Smith, Joseph H. T. Smith, Robert F. Smithies, Sanuel Smyth, Andrew	The College School, Taunton St. Thomas', Charterhouse Chemical Works, Kilmarnock Training College, Westminster Budowed School, Oldosath, Co. Mestn	:::::	:::::	::::	:::::	* : : : :	٠::::	∞ : : : :	::::	ं व्यक्तका	::-:	:::::			::::	::::	:::::		:::::	:::::	::::	٠:::
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		Name.	Snell, Daniel - Snelus, George J Sollas, William J	Sparkes, Arthur J.	Spear, John J.	Speers, Adam Spencer, James Spink, John Spriggs, Christopher	Stanton, George	Stead, Wilbraham Stevenson, James Stevenson, J. H.N. Stewart, John Stiles, James J.	Stirrup, Thomas Stockton, William	Stone, William - Strachan, Richard - Strond, Robert -	Stubbe, Richard H.O.
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Navigation School, Waterford Bridge Street, Frome 86, Princes Street, Stepney	St. Mark's College, Chelsea Geological Society, Somerset House Training College, Battersea F. Havelock Terrace, Brooks Bar, chester. Darfield School, Barnsley	St. Mark's College, Chelsea 3, Colleton Buildings, Exeter St. Mark's College, Chelsea Newcastle-on-Tyne	Grove Street, Huddersfield Frampton Cotterill, Bristol 12, Westbourne Grove North, Lond Rose Hill East, Brighton Royal School of Naval Architecture	Queensland National School, Halifar 4, Marlbro' Terrace, Victoria Road, Ken-	Privy Council Office, Whitehall National School, Cainscross, Strond	British School, Torquay Royal School of Naval Architecture 29, Brewer Street, Pimlico Wesleyan College, Westminster St. Mark's College, Chelsea	Northallerton, Yorkshire - Mechanics' Institution, Leeds Bridge Street, Bolton - Training College, Battersea High Street, Slough	The Grammar School, Deptford IT, Bloomsbury Square, London Pennyman School, North Ormesby Wesleyan Day School, Newark
Sullivan, Michael Swaine, James Talmedge, Anne E.	Tarran, Daniel J. Tate, Ralph Taylor, Charles Taylor, Samuel Taylor, William	Thackrah, Samuel - Thomas, James D Thompson, George - Thorn, Wm. H Tilden, William A	Tindall, George Tomkins, Samuel Tribe, Alfred Trower, Eichard Turnbull, Thomas	Turner, George Turner, Samuel C.	Twite, Charles	Viccars, Thomas Vizetelly, Adrian Vosper, Thomas Waite, John Walker, Francis L.	Walton, John S. Ward, George Ward, Thomas Warner, William Watson, Joseph	Watkins, James Watts, John Weatherill, Robert Webster, James H

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Table showing Certificates held by Science Teachers-continued		Address.	Science School, Wolverton National School, Middleton St. Mark's College, Cholsea St. Mark's College, Cholsea St. Mark's College, Cholsea Eastington, Stonehouse, Gloucestershire	St. Mark's College, Chelses St. Mark's College, Chelses Z4, Market Pasce, Manchester Z4, Albion Grove West, Barnsbury, N. St. Mark's College, Chelses	39. Olifton Road Bast, St. John's Wood 62, Clarendon Street, Nottinghan Training College, Westminster 27, Ash Grove, Bradford, Yorkshire	Prestbury Road, Macclesfield 31, Richmond Place, Brighton The Grammar School, Bosworth, Hinckl 29, Queen Street, Edgehill, Liverpool	Midland Institute, Birmingham St. Mank's College, Chelsea Models School, Ballymena St. Mank's College, Chelsea Pennifelds, Wolverhampton
	•	Name.	Wheeler, George H. Wheeler, George H. Whitehead, John E. Whitehouse, Henry I. Wilcox, Edward	Wild, Robert Wild, William I. Willcock, Joseph Willey, Thomas	Williams, W. M. Williamson, Stewart Wilson, Thomas Winney, William Winter, William	Wire, Alfred P. Wood, Charles H. Wood, Edward - Woodcock, Fred.W Woodhead, William	Woodward, Chas. J. Woollett, John Wron, Edmond Wynn, William T. Yates, Frederick

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SCIENCE AND ART DEPARTMENT OF THE COMMITTEE OF COUNCIL ON EDUCATION, South Kensington.

DIRECTORY,

(Revised to April 1866.)

14th EDITION.

WITH

REGULATIONS

FOR

ESTABLISHING AND CONDUCTING

SCIENCE SCHOOLS & CLASSES.

THE RULES IN THE PRESENT EDITION SUPERSEDE THOSE IN ALL FORMER EDITIONS,
BUT ARE ALWAYS SUBJECT TO REVISION.





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1866.

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SCIENCE AND ART DEPARTMENT.

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CROMWELL ROAD, SOUTH KENSINGTON.

Lord President, The Right Hon. the Earl GRANVILLE, K.G. Vice-President of the Committee of Council on Education, The Right Hon. H. A. BRUCE, M.P.

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Assistant Secretary.-Norman MacLeod.

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Deputy Head Master.-R. W. Herman.

Mechanical and Architectural Drawing .- H. B. Hagreen.

Geometry and Perspective.—C. M. Clarke.

Painting, Freehand Drawing of Ornament, &c.. the Figure and Anatomy, and
Ornamental Design.—R. Burchett, R. W. Herman; W. Denby; B. Collinson; C. P. Slocombe.

Modelling .- F. M. Miller.

Lady Superintendent of Female Students.—Miss Trulock.

Female Teachers.—Mrs. S. E. Casabianca; Miss Channon.

Lecturer on Anatomy.—J. Marshall, F.R.S., F.R.C.S.

Lecturer on Botany.—Christopher Dresser, Ph. D. (Jena).

ROYAL SCHOOL OF NAVAL ARCHITECTURE AND MARINE ENGINEERING.

Inspector General and Director of Studies.—Rev. Joseph Woolley, LL.D.

Principal. - C. W. Merrifield, F.R.S.

Vice Principal.—Henry Martyn Taylor, B.A., Scholar, Trinity College, Cambridge.

Instructor of Naval Drawing .- W. B. Baskcomb.

Instructor in Engineering Drawing.—John Maxton.

Instructor in Practical Chemistry. - John Davidson.

Instructor in French.-M. Penon.

Summary of the Nature and Amount of Assistance afforded by the Science and Art Department to the Industrial Classes in procuring Instruction in Science.

[Important Alterations made since the last edition of the Directory are printed in Italics.]

- I. A sum of money is voted annually by Parliament for scientific instruction in the United Kingdom.
- II. This sum is administered by the Science and Art Department.
- III. The head of the Education Department of which the Science and Art Department is a branch is the Lord President of the Council, assisted by a member of the Privy Council, who is called the Vice-President of the Committee on Education, and who acts under the direction of the Lord President, and for him in his absence. (Order in Council, 25th February 1856, Act 19 & 20 Vict. c. 116.)
- IV. The object of the grant is to promote instruction in Science especially among the industrial classes,* by affording a limited and partial aid or stimulus towards the founding and maintenance of Science schools and classes.†
- V. The payment of fees by the students can be looked upon as the only solid and students. Sufficient basis on which a self-supporting system can be established and supported. Though my Lords do not consider it necessary at present to lay down any rules making the payment of fees an absolute condition of the grants on account of Science

^{*} Direct payments are made to teachers only on behalf of adult artisans, or the children of artisans, or the children of persons who are not assessed to the income tax, that is, who do not possess an income of 100l. a year. (See § xviii.)

[†] The amount is liable to be decreased and eventually withdrawn. Payments to teachers therefore must not be looked upon as perpetual, or in any way conferring on the teacher a claim to any payments beyond those offered for each current year.

instruction, yet as the payments from the State must be expected to diminish, and as aid on account of those persons who do nothing for themselves cannot be justified, Committees of schools and classes and Teachers are strongly urged (should it at present not be the practice) at once to impose as high a scale of fees as they consider can be raised not only on middle class students but also on artisans.

VI. The following are the Sciences towards instruction in which aid is given:—

Subject 1, Practical Plane and Descriptive Geometry.

,, 2, Mechanical and Machine Drawing.

3, Building Construction or Naval Architecture.

4, Elementary Mathematics.

5, Higher Mathematics.

, 6, Theoretical Mechanics.

, 7, Applied Mechanics.

,, 8, Acoustics, Light, and Heat. ,, 9, Magnetism and Electricity.

", 10, Inorganic Chemistry.

" 11, Organic Chemistry.

,, 12, Geology. ,, 13, Mineralogy.

" 14, Animal Physiology.

" 15, Zoology.

11

" 16, Vegetable Physiology and Economic Botany.

,, 17, Systematic Botany.

" 18, Mining.

" 19, Metallurgy.

20, Navigation.

" 21, Nautical Astronomy.

" 22, Steam.

" 23, Physical Geography.

VII. The assistance granted by the Science and Art Department is in the form of—

1. Payments on results to certificated teachers. (See § xv., xviii., and xix.)

2. Grants towards the purchase of apparatus, &c.

(See § xxi.)

3. Public examinations in which Queen's Medals, Honorary Certificates, and Prizes are awarded, held at all places complying with certain conditions. (See § xi., xii., xiii., xiv., xv., xvi., and xvii.) On the results of these examinations the payments are made to the teachers. (See § xv. and xviii.)

VIII. Examinations for certificates to Examinations teach any of the before-mentioned sciences Certificates. are held annually, commencing in the first week in November, at South Kensington. nations will also be held in Dublin, Edinburgh, and Manchester if five candidates register themselves for examination in Ireland and in Scotland and in the north of England. Any person whatever may attend this examination by sending in his or her name to the Secretary of the Science and Art Department, before the 15th October, stating the subject or subjects in which he or she wishes to be examined. Certificates of three grades are given in each subject. These certificates are only considered as simple records of the results of examination in the various sciences before mentioned, entitling the teacher to earn payments by successful teaching in the subjects for which he or she is certificated.* No payments can be made to a teacher on account of instruction in subjects in which he is not certificated.

IX. Suitable premises, with firing, lighting, &c., must be found and maintained
at the cost of the locality where the school or class
is held. If at any time the funds do not cover
these requisite local expenses, it must be inferred
that there is no such demand as the Government is
justified in aiding, for instruction in the locality; and
the assistance of the Department will be withdrawn.

^{*} Such examination may be dispensed with in cases where the candidate has taken a degree, the examination for which satisfactorily meets the requirements of the case. Full particulars must be furnished by the applicant.

Local Committee of not less than five well known responsible persons must be formed in connexion with every Science Class, who will carry out the instructions contained in Appendix. (See pages 14 and 18 to 22.)

Examination XI. The Science and Art Departof Classes ment holds annually in May (see Science under Cer-Form, No. 232, page 59), through the agency of the Local Committees, a public examination of all Science schools and classes in any locality throughout the United Kingdom which complies with the requisite conditions. (See § x., xiii., and xiv.) On the results of this examination the payments are made to certificated teachers. (See § xv. and xviii.) Application for it must be made before the end of March in each year, stating the number of persons and the subject or subjects in which they are to be examined. The form of application, Science Form No. 119 (see page 22), will be sent on application to the Secretary, Science and Art Department.

In addition to the above, examinations in mathematics, navigation, nautical astronomy, steam, and physical geography are held for the benefit of seafaring men, and for them only, three times a year in all seaports where Local Committees are formed and are willing to undertake them. These examinations take place in the beginning of March, September, and December. The application for these examinations must be made on Science Form No. 119 before the 10th day of the previous month.

Examination of other classes.

A teacher not holding a certificate, may, by applying to the Secretary of the Science and Art Department, be examined at the same time and in the same manner as the classes under certificated teachers: provided that a Local Committee be formed which complies with the requisite conditions. (See Appendix, page 21, Science Form, No. 88 a.)

If the class be for artisans the pupils are eligible to receive Queen's Prizes and Queen's Medals under the same condition as the pupils of certificated teachers. Should it however be for the middle classes the pupils are not eligible for prizes and medals, but receive certificates of merit instead.

XIII. If two or more classes in the same Places of town, or within a reasonable distance of one another, apply for the examination of the Science and Art Department, a general examination committee must be formed by the amalgamation of the several Committees to carry out the examinations at some common centre, such as the town hall or other public building. It is only when the classes consist of 100 or more candidates that such amalgamation of the committees will not at present be insisted on.

XIV. Any persons whatever, whether taught by the certificated teacher or not, students may present themselves at the Local Committee's examination on registering their names in time for the Local Committee to comply with the instructions, and paying a registration fee of not more than 2s. 6d. each. Arrangements must therefore be made by the Local Committee, or the General Examination Committee, as the case may be, to enable other candidates, besides the students in the class for which the Committee act, to present themselves at this examination. The registration fee of 2s. 6d., which such candidates may be required to pay, is to reimburse the Committee for any extra expenses incurred by such attendance, and may at their option be remitted.

XV. The successful candidates at the Classification of Results.

May examination and the quarterly examinations of seamen are classified under the heads of first, second, third, fourth, and fifth class. The standard of attainment required may be raised from year to year. For the fifth class it is only such as will justify the Examiner in reporting that the instruction has been sound, and that the students have benefited

by it. Those who have attained a higher degree of proficiency are classed as 4th, 3rd, 2nd, or 1st class, according to their merit.

Queen's AVI. To the 1st, 2nd, and 3rd class are given Queen's prizes consisting of books or instruments chosen by the candidates from lists furnished for that purpose. These are unlimited in number, and are open to all candidates who come within either of the following categories, except as below, see a. and b. (1) Students in Science Classes under Certificated Teachers; (2) Registered Students in Artisan Classes taught by Non-certificated Teachers, or (3) bonà fide artisans.

Other candidates, if successful, receive instead Cer-

tificates of merit recording their success.

The following are exceptions to the above rule.

a. Science Certificated Teachers; and

b. Students who have previously received the same, or a higher class prize, in the same subject.

The names of such candidates will simply be re-

corded in the published lists.

Queen's Medals. XVII. To the four best in each subject are awarded Queen's medals. These consist of one gold, one silver, and two bronze in each subject for competition throughout the United Kingdom. They are only awarded if there are a sufficient number of qualified candidates, and the gold medal will only be given in cases of high merit specially recommended by the examiner. The same candidate cannot obtain the same medal in the same subject more than once.

Only registered students of schools and classes under Local Committees (see § x. and xii.) are eligible for medals. They cannot be taken by middle class students who are more than 17 years of age. Students who but for this restriction would have taken the medal, will receive an honorary certificate instead. Should a student take more than one gold, silver, or bronze medal, he will receive books instead of a second medal.

XVIII. Payments are made to the Payments to certificated teacher on account of the instruction of students of the Artisan Classes (for definition of Artisan Class see Science Form No. 51, page 24) in the following manner:—

11., 21., 31., 41., 51. are the claimable payments for each student in each subject, according to the class in which he passes, but these amounts may be reduced

in the following ways:

1st. If the student has been successful in the same subject before such payments are reduced by the normal payment which was claimable on such previous success; for instance, the 4l. payment for a second class would, if the student had previously taken a fourth class, be reduced by 2l.*

2nd. If a student be successful in more than one subject at an examination, the payments on account of such further subjects are reduced by one half.

3rd. When on this scale they would amount to more than 60l. the excess up to 40l. is diminished by one quarter, the excess above 40l. by one half. Thus payments which on the above scale would be 100l. and 150l. will be reduced to 90l. and 115l. respectively: †—provided that the student has received 25 lessons ‡ at least from the teacher in each subject in which he claims payment since the last examination, each lesson being an attendance at a meeting of the school of at least three-quarters of an hour's duration on a separate evening. The 25 lessons need not neces-

† Thus, 100, that is 60+40, is reduced to $60+40-\frac{1}{4}$ of 40 = 60+30=90. 150, that is, 60+40+50 is reduced to 60+30+25=115.

^{*} Deductions will be made in payments on account of Subject I. to the amount of any payments that have been made on Second Grade Examinations in Art, in practical geometry, perspective or mechanical drawing.

[‡] It must be clearly understood that the number (25) of lessons which the teacher is required to give is the minimum fixed as a criterion that the pupil has received his instruction from the teacher. It is not meant in any way to specify that that amount of instruction is sufficient, or to guarantee the teacher's receiving payment, if that amount of instruction alone is given.

sarily be all given in one year, but may extend over a longer period.

Form of Claim for Payment. XIX. The claim of a master for the payments under these several heads is made on Science Form No. 51, which will be sent on application. The voucher must be signed by the secretary and two members of the committee of the science class or school; or by at least three of the committee. (See Appendix, page 24.)

School Register. XX. A school register must be kept in each subject on a form which will be supplied on application. This must be made up from day to day, and will be examined and approved by the Inspector on his visit. It must be sent to the Department with the teacher's claim for payment, and no payment can be made unless it is properly kept.

AXI. A grant towards the purchase of apparatus, diagrams, &c., of 50 per cent. on the cost of them, is made to science schools and classes in Mechanics' and similar institutions where the teacher is certificated, and to the extent of 51. to other poor schools and classes. A requisition must in these cases be made on Science Form, No. 49. (See page 30.)

Travelling Expenses of Teachers.

XXII. The travelling expenses (second-class railway fare, and 10s. per diem personal allowance) of a candidate in attending the November examination are paid if he be successful in taking a certificate or in improving the grade of one he has already taken, provided the candidate is bonâ fide engaged in tuition, or is preparing for tuition.

Instruction in an Elementary School.

XXIII. All payments to certificated teachers on account of Science teaching are made by the Science and Art Department, and are only made in respect of a school in connexion with the Science and Art Department.

No such payments are made in respect

of any instruction in Science that may be given during the three attendances of an Elementary School receiving aid from the Education Department, Whitehall.

XXIV. These grants are only made While the teacher is giving instruction School in a day or evening school or class Premises. for the industrial classes (adults or boys), approved by the Science and Art Department, and open at any time to the visit and inspection of its officers. The Managers of an Elementary School under the inspection of the Education Department can permit their premises to be used for Science teaching, provided that no interference be allowed with the primary purposes of such Elementary School, or in any way with the three attendances of the Elementary School.

N.B.—On the next page will be found a table of memoranda for the use of Secretaries and Members of Science Committees (Science Form, No. 170) which it is expected will be carefully attended to. This, as well as the other forms given in the Directory, can be had on application to the Secretary, Science and Art Department.

APPENDIX.

SCIENCE FORM, No. 170.

MEMORANDA FOR THE USE OF SECRETARIES AND MEMBERS OF SCIENCE COMMITTEES.

Dates.

Before 30th November.

Constantly - -

Before 1st January

Before 31st March

Before 24th April -

On the 27th April

During the May examinations.

On the evening of examination.

After the May examinations.

Formation of Committee, Form No. 88. Or continuation of Committee, Form No. 168.

To visit the School and see that the Register is kept from day to day, and that everything is regular.

To carefully fill in and send to the Department Form No. 120.

To send Form No. 119 applying for examination in May.

To see that Form No. 91 is hung up in the Schoolroom.

If a parcel containing (1) the papers for the candidates to work upon, (2) copies of Form No. 91, one for each day's examination, and (3) envelopes in which to return the worked papers, should not have been received, or if there should be any mistake in the numbers sent for each subject as applied for, or in the covering letter, to communicate at once to the Department.

The examination papers for each evening will leave London by the night mail two evenings before, i.e., Thursday evening papers will leave on Tuesday evening, Friday's on Wednesday evening, etc. Should they not arrive accordingly, a telegram to be sent at once to the Department.

The candidates, being all seated at 6.50, to read out the rules on Form No. 91, then give out the papers to be worked on. Then at 6.55 to break the seal of the examination papers and distribute to the candidates. To adhere rigidly to the rules on Form No. 91. To sign Form No. 91. To seal up the papers in one of the envelopes provided and at once post them.

On receiving lists of the results to give one copy to each candidate whose name appears in it as being successful; to inform the others they have

To return Form No. 161 filled up as soon as possible in strict accordance with the rules on Form No. 110. (Prize List). To return Form No. 123. To examine and certify Teacher's claims for payment, Form No. 51, and the School Register, which must be sent up at the same time. To return Form No. 108.

To keep a record of, and inform the Department of the number of individuals examined.

EXHIBITIONS AND FREE ADMISSIONS AT THE ROYAL SCHOOL OF MINES, LONDON.

ROYAL EXHIBITIONS.

1. There are eight Royal Exhibitions to the Royal School of Mines, Jermyn Street, of the value of 50l. per annum, entitling the holders to free admissions to all the lectures, and to the Chemical and Metallurgical Laboratories at the Royal School of Mines, to be held from year to year for three years, on the condition that the holder attends the lectures regularly during those years, and passes the examinations required for the associateship of the School.

At the May 1866 examination two of the above Royal Exhibitions will be open for competition independently of the prizes, &c. offered by the Science and Art Department.

All persons over 21 years of age, excepting artisans, and such as come within the category of persons paid upon under the Science Directory, will be excluded from competing for the Royal Exhibitions. Special cases, however, must be determined according to the spirit of the rules, and the object of the endowment.

The competition for the Royal Exhibitions will be determined by affixing the following values to the several results of the May examination (see Science Directory), viz.:—

To a 1st grade Quée	n's Pri	e, in any subject		- 9 m	arks.
To a 2nd "	,,	,,	-	- 7	
To a 3rd "' ,		,	-	- 5	**
To a 4th ,, -	-	٠ "	-	- 8	,,
To a 5th "' -	••	• "	•	- 1	**
and in addition-					
For a gold medal	•	- ´"	-	- 10	,,
For a silver medal	-	- "	-	- 7	
For a bronze medal	•	- "	-	- 5	33

N.B.—Science Certificated Teachers may compete for the Royal Exhibitions. When coming up simply with this object, they should inform the Science and Art Department, so that their names may not appear in the published list with the students.

FREE ADMISSIONS.

2. Free admissions to the lectures at the Royal School of Mines, Jermyn Street, are granted to any person who takes a gold medal in the May examination.

EXHIBITIONS AND FREE ADMISSIONS AT THE GOVERN-MENT SCHOOL OF SCIENCE, DUBLIN.

ROYAL EXHIBITIONS.

1. There are ten Royal Exhibitions to the Government School of Science, Dublin, of the value of 50l. per annum, entitling the holders to free admission to all the lectures and the chemical and metallurgical laboratories at the Government School of Science, Dublin, to be held from year to year for three years, on the condition that the holder attends the lectures regularly during those years, and passes the examinations required for the associateship of the school.

At the May 1866 Examination three of the above Royal Exhibitions will be open for competition, independently of the prizes, etc. offered by the Science and Art Department.

All persons over 21 years of age, excepting artisans and such as come within the category of persons paid upon under the Science Directory, will be excluded from competing for the Royal Exhibitions. Special cases, however, must be determined according to the spirit of the rules, and the object of the endowment.

The competition for the Royal Exhibitions will be determined by affixing the following values to the several results of the May Examination (see Science Directory), viz.:—

To a 1st grade Q	meen's	Prise,	in any	subje	ct, 9 m	arks
To a 2nd	99				7	83
To a 3rd . "	89	-			5	
To a 4th 🙀					8	20
Toa5th				80	. 1	*
and in addition-		•				
For a gold medal	L			_	10	
For a silver med					7	20
For a bronze me	dal,			"	5	,,
				-		

N.B.—Science Certificated Teachers may compete for the Royal Exhibitions. When coming up simply with this object they should inform the Science and Art Department, so that their names may not appear in the published list with the students.

FREE ADMISSIONS.

2. Free admissions to the lectures at the Government School of Science, Dublin, are granted to any person who takes a gold medal in the May Examination.

The following candidates at the recent May Examinations are candi-
dates for the Royal Exhibitions at the*
and they are either—
1. Under 21 years of age.
Or artisans or operatives in the receipt of weekly wages, supporting themselves by their own manual labour, or their children not earning their own livelihood.
 Or, although not artisans, yet such as may fairly be considered as belonging to the industrial classes, as coming within one of the following categories, or being the children of such.
a. Though paid at longer intervals than a week, still supporting himself by his own manual labour and not by profit on the labour of others, that is, not employing apprentices, journeymen, etc.
b. Though not supporting himself by manual labour, yet being of the same means and social level as those who do so, (such as shopkeepers who have only petty stocks and employ no one but members of their own family,) policemen, coast-guards, etc.
c. Though not supporting himself by manual labour, yet such as it would be unreasonable to expect to pay the fee of middle class students, as some descriptions of clerks, shopmen, etc., and we certify that they or—in case they are not earning their own livelihood—their fathers are not assessed to the income tax.
4. That they are entitled to be considered as a special case on the following grounds:—
We hereby certify that the above particulars are correct. Chairman or Secretary. Two members of the
Committee.†
* After each name must be stated all the successes of the candidate at the May Examinations and the category under which he claims.
† Should the candidate not have been a student in any Science School of Class under a regular constituted Committee, this voucher must be certified by three householders whose occupation and address must be given in full,

SCIENCE FORM, No. 88.

LOCAL COMMITTEES FOR SCIENCE SCHOOLS AND CLASSES.

- 1. A Local Committee of not less than five well-known responsible persons must be formed in connexion with every Science class, in order to comply with the necessary requirements of the Science and Art Department, and to carry out various arrangements on its behalf necessary for testing the efficiency of the science instruction, on the proof of which alone the aid of the Department is given.
- 2. The gentlemen proposed to act on this Committee are to fill in the form on the next page, stating their willingness to carry out the necessary arrangements for examinations, &c., and giving the address and occupation of each member.
- The relation of the Committee to the teacher of a Science school or class will vary much according to the varying circumstances of different In some places where the demand for science instruction is great, and there is an energetic local teacher to take advantage of it, the chief duty of the Local Committee may be to give the teacher the necessary vouchers for obtaining his payments. While in other places, where those who take an interest in and wish to further science instruction may, with that object, subscribe to and establish scientific classes either in connexion with an existing institution or not, and may engage a teacher certificated in science to instruct the classes, the teacher must, to a great extent, be the paid officer of the Committee. With these local arrangements the Science and Art Department does not interfere, but leaves them to the locality to settle. The local circumstances will determine whether, as in the first case, the master receiving the whole of the fees for instruction should provide at his risk the room for instruction, with the necessary firing, lighting, &c., or what, as in the second case, should be the proportion of the fees deducted on this account by the Committee.
- 4. The Science and Art Department requires that the Local Committee shall
 - a. Be responsible for the safe custody of all apparatus towards the purchase of which the Department has paid 50 per cent.
 - b. That they shall provide a room or rooms of sufficient size to carry out the annual examination according to the detailed regulations under that head. This examination is of all persons who wish to present themselves, and not only of those taught by the certificated teacher; but those persons who are not taught by the certificated teacher must send in their names before the 1st March, and may be required to pay a registration fee of 2s. 6d. for the whole examination.
 - c. That a school register, showing the attendance, number of lessons, payment of fees, &c., on an approved form, be kept properly filled up, and sent to the Science and Art Department when required.
 - d. That they shall send in to the Secretary of the Science and Art Department the list of students to be examined, before the end of March, specifying the subjects in which they are to be examined. That they shall be responsible for conducting and superintending the examination: giving out the examination papers which will be

- sent for that purpose: seeing them worked fairly and certifying to the same, not less than three of the Committee being always present: and sending the worked papers, under seal, by the day's post to the Secretary of the Science and Art Department.
- e. That they shall certify, firstly, that those students on whose examination the teacher bases his claim to payments on results, are artizans or operatives, or their children, or can claim as such (see Science Form, No. 51); and, secondly, that they have received 25 lessons at least from the teacher in the year or since the last examination, on their passing at which payment was claimed on their account.
- 5. The Science school or class must be at all times open to the visit and inspection of the officers of the Science and Art Department as a condition to the grant of aid from it; if at any time it is found that the apparatus, &c., towards the purchase of which a grant has been made is not properly taken care of, or that a proper room with firing, lighting, &c., is not provided for the class, the aid of the Department will be withdrawn.

NOTE.—As it is to the Committee that the Department looks to carry out the great proportion of the duties of the school, as many as possible of the members of the Committee should attend on the inspector's visit.

FORM of APPLICATION to act as a COMMITTEE for a Science School or Class. We the undersigned,

[f. The Committee shall be composed entirely of well-known responsible persons of position who are quite independent of the school or class, and who have no such personal interest in it as can lay them open to the slightest suspicion of partiality; and of course no member should be connected with the Teacher have any pupils for examination, or be a pupil himself.
g. It is very destribule that as many persons as possible in recognized positions of public responsibility in the district, such as Magistrates, Municipal Authorities (Mayor, Aldermen, or Town Councilors), Head of Educational Establishments (Trustees of Grammar Schools, Managers of National Schools), A. It is absolutely necessary that at least two such responsible persons should

h. It is absolutely necessary that at least two such responsible persons should agree to act.

i. The Committee must consist of a Chairman, Secretary, and at least three other

Members.

Members.
 The Chairman must be a Magistrate, Mayor, Boroughreeve, Provost, or Alderman, or other public officer of recognized position, Trustee.of. Grammar School, or Clergyman of the Established Church in parochaid employment.
 The Chairman of the Committee will infura Tydoria as to the constitution of the Committee being in accordance with these requirements.
 The Secretary of the Committee of the Science School or Class, as being the medium of communication, will carry on all correspondence with the Science and Art Department, and is held responsible for making out and sending all returns required, for the receipt and distribution of the examination papers, the transmission of the worked papers, &c., at the proper times according to the regulations; and in consequence of the necessary demands on his time and trouble My Lords have sanctioned, provisionally, the payment to him of the following fees:—1t. annually for furnishing the returns, &c. specified on Science Form, No. 170, connected with any Science school or class, and it, in addition for each day's examination held by the Committee to which he is Secretary. The Secretary must be a member of the Committee; the requirements in par. 1 apply equally to him.
 This form is to be filled in and returned to the Department annually before the 18th December, except in the case of new schools or classes, when it should be made as soon as they are formed.]

propose	to	act	88	the	Local	Committee	for	the	Science	Class	held	at
												
and tone	shi 1	w										

We undertake for the year at least, and further till another Committee satisfactory to the Science and Art Department has been appointed,

- To be responsible for the safe custody of all the Apparatus, Diagrams, &c., towards the purchase of which the Department has in any way contributed.
- 2. That three or more of our number will be ready at the appointed time to be present at, and superintend, the examinations of the Science Class according to the instructions of the Science and Art Department, and give the teacher the necessary vouchers.
- 3. That a room or rooms shall be provided for the due carrying out of such examination, according to the rules of the Department, providing sufficient space for the examination, not only of all persons taught by the certificated teacher, but of all others who may wish to attend the examination.
 - (A fee of not more than 2s. 6d. may be charged on each applicant for examination who is not a student in the class, to reimburse the Committee in any extra expenses they may be put to in providing a room).
- 4. That the School or Class shall be open at any time to the visit and inspection of the Officers of the Science and Art Department.

Signature.	Address.	Occupation, specially stating how fulfilling the conditions of "g." and "k." above.
Chairman.		
Secretary.		

I certify that this Committee complies with the requirements of the rules 1, 2, 3, 4, and 5.

Chairman.

The Secretary.

Science and Art Department.

This form may be had on application to the Secretary, Science and Art Department, South Kensington.

SCIENCE FORM, No. 168.

Where the same Committee proposes to act again it will not be necessary to re-sign the above, No. 88, but only to hold a meeting and fill up this form, No. 168, which may be had on application.

SCIENCE FORM, No. 88 a.

LOCAL COMMITTEES FOR SCIENCE SCHOOLS AND CLASSES NOT RECEIVING AID FROM BUT EXAMINED BY THE SCIENCE AND ART DEPARTMENT.

This Form is a modification of the previous, No. 88., and may be had on application to the Secretary, Science and Art Department, South Kensington.

SCIENCE FORM, No. 120.

SCIENCE CLASSES UNDER CERTIFICATED TEACHERS. ANNUAL REPORT OF SCIENCE SCHOOL OR CLASS,

To be made on its establishment, and annually (before the 1st January) of its continuation. Name of Town Place, as Mechanics' Institution, &c., in which the Classes are held____ Name of Street, No., &c. Name of Teacher or Teachers Their private addresses_ Total No. of individual Students (If a student attends two or more classes he must only be counted as one student.) Period of the Year Days on which Hours of No. of CLASSES IN during which Meeting. Fees. they meet. (state subject). Students. the Classes continue.

NAMES OF SECRETARY AND MEMBERS OF THE COMMITTEE.

(The undertaking on Science Form, No. 88, is for the year at least, and further till another Committee satisfactory to the Science and Art Department has been appointed. This Form, No. 88, must therefore be filled in and sent to the Department annually when the class recommences, except in those cases in which the whole of the Committee, wishing to continue, formally authorize the Chairman and Secretary to report to that effect. It will then only be necessary for new members to sign the form undertaking to perform the various duties.)

SCIENCE FORM, No. 119.

APPLICATION FROM

SCIENCE SCHOOL FOR EXAMINATION IN MAY.

To be sent to the Secretary of the Science and Art Department before the end of March.

	·iiixx	Physical Geo- graphy.	
	IIXX	Steam.	
	'IXX	Vantical Astro-	
	.xx	General Mayiga-	
	.XIX	Metallurgy.	
	XVIII	Mining.	
:	TIAX	Systematic Bo- tany.	
	'TAX	Vegetable Physi- ology and Eco- nomic Botany.	
5	.vx	Zoology.	
	.VIX	Animal Physi-	
3	TIIX	Mineralogy.	
5	.IIX	Geology.	
	· 'IX	Organic Chemis- try.	
	.х.	Inorganic Che- mistry.	
	.XI	Magnetism and Electricity.	
	'III'A	Acoustics, Light, and Heat.	
	TIA	Applied Mecha-	
	'IA	Theoretical Me- chanics.	
3	Λ.	Higher Mathe- matica.	
1	·ΛΙ	Elementary Ma- thematics.	
3	.III	Building Con- struction.	
to be seen to make postering of the posterior and the posterior process and the control process of the control pro	п	bna laoinadheM wardi e maram yari Sui	
3	·I.	Practical, Plane, and Descriptive Geometry.	
			Number of students under in- struction during the year Number intending to present themselves for examination Number intending to present themselves for examination not belonging to the class

Total number of students * intending to present themselves for examination. Total number of students * under instruction during the year...

Name and address of the person to whom the examination papers are to be sent.

N.B.—The address must be that to which the Examination papers are to be sent.

Specify here the arrangements which have been made in accordance with § XIII. of the Science Directory to conduct the examination of any other classes in the town (if there be any) at the same centre.

* The total number of individual students only should be here given, so that if one student attends two or more classes he must only he counted as one.

FORM No. 363.

The following form, which may be had on application to the Secretary, Science and Art Department, is filled up in italics as an example of the manner in which it should be done.

An Account of Travelling and Personal Expenses disbursed and Charged by

Thomas Jones,

From the 2nd November 1860, to the 4th November 1860.

I hereby certify that the travelling expenses detailed below have been actually disbursed by me in travelling in the execution of my public duties, that the personal expenses are charged according to the regulations, and that the total sum of £1 13s. 8d. is due to me for the services stated.

In this column must be stated the service on account of which the journeys were performed, and the details of the expenses incurred.

Date

upon which the

services were

Thomas Jones.

TOTAL

AMOUNT.

[Name and title of officer to be specified.]

Teacher of Chemistry in _____School of Brighton.

1860.	To attend ea			mistry held ember 1860.	aŧ					
and November.	Railway fa	re from	Bright	n to Lond	ON C	6	4	ł		
ard November.	Omnibus far South Kens	e to and 1	rom Cha	ring Cross a	nd ¯	٠	Ĭ	l		
4th November.	Railtoay far	e from La	mdon to	Brighton	- 0	6				
	s days' person	ial allowa	nce at 10		. –	•	-	0	18 0	8 0
								7	18	<u> </u>
1								<u> </u>		<u> </u>
NOTH.—Should to get home at ni	the successful control	o be allow	ed 58. per	diem beside	his t	acc. Tav	or n ellin	g ex	Pon Pon	168.
Examined an	d approved.									
				Secretary.						
			:							
Received thi	8	day of_	:		_18		, ւ	ie si	ım	of
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	s	•		and			•			
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	oounds	•					•			



SCIENCE FORM No. 51.

SCIENCE AND ART DEPARTMENT OF THE COMMITTEE OF COUNCIL ON EDUCATION, SOUTH KENSINGTON.

Applic	cation from			Science	e Teach	her in	
		at				or payment.	
On be		Com	mittee of Man	agemen	t of thi	is School, We do	hereb
. (1). T	hat Mr evolving up	on h	im as a Scienc	e Teac	her in	formed the various the School, dur	ıs duție ing th
tł o: (3). T	ne ye ar, or a n their acco That the un	since ount, der-n	the last exami in each subject mentioned stud	ination t for wi ents are	at whic tich pay artizan	least 25 lessons h payment was rment is claimed us or operatives s by their own	claime
			hildren not ears				
						Tw b Cor	ary. o mem- ers of nmittee
N R T h	NAMES	OF I	PASSED ARTIZA	N OR O	PERATIF.	E STUDENTS.*	scher.
den in t	t's name mu he last colu uctions.	st be mn t	placed his sever he amount clain	al succes ned on es	ses (if h ch succe	e has more than o ess after making th	ne); and le prope
Surname.	Christian Name in full.	Age last Birthday.	Trade, or father's trade. (State which is given).	the	ion at late nation.	Highest Position in same Subject at any previous Examination.	Pay- ment claimed
	-	-		·			<u> </u>
		-					
			2 1 common 1				ļ
9-0							·

^{*} Should the Tcacher have instructed any Students who may fairly be considered to belong to the industrial classes, but whose wages are paid at longer intervals than a week, or who do not support themselves by their own manual labour, the claims on their account must be made by the Committee of the school on the form on page 3, when they will be considered on their merits.

to recomme claim the a be taken as following ca. Thou, his is n b. Thou, mea have fam c. Though be used to be	end that illowances of belonging ategories, ogh paid at own manus ot employing the sum of the sum o	to t	eacher, Mr. — e following structure in the industrial cong the childrene er intervals the cour and not be our and not be our and not be our and not be our and masself by revel as those we cks and employ coast-guards, and himself by expect to pay felerks, shopm our belief— them (25) less on at which payment which payment which payment which payment was they are not seed to the incomparticulars of the congression of the congressi	idents, idents	whom vasas combh. ck, still on the , &c. labour, so such the but relations of mides at during their med.	supporting himselabour of others, yet being of the as shopkeepers members of their, yet such as it vidle class studenting the year, or med on their accown livelihood—Teacher ground	ed to fairly of the elf by that same (who own would ats, as since count, their
appl	lication are	corr	ect.			Secretar	v.
	-		following par			Two: berr Comm	mem-
N.B.—The name	ames of the must be plac	stude ed his	nts must be arra several successe med on each suc students in categ Trade, or father's trade.	nged alp s (if he h cess with yory "c" Posit the	habetice as more that he pro- a line n	Highest Position in same subject	dent's he last
	full.	Bir	(State which is given).	Subject.	Grade.	at any previous Examination.	claimed
		-					
		-					
&c.							
The Secret	ary, se and Art	Depa	artment.			•	,
			culars will be set to the exten		at Sou	th Kensington.)	
Approved				day			86



[SPECIMEN.]

Science Form, No. 51. South Kensington, July 1865.

SCIENCE AND ART DEPARTMENT OF THE COMMITTEE OF COUNCIL ON EDUCATION, SOUTH KENSINGTON.

Application from John Smith, Science Teacher in the Science School or Institution at Midhurst for payment.

On behalf of the Committee of Management of this School, We do hereby certify:—

(1.) That Mr. J. Smith has duly performed the various duties devolving upon him as a Science Teacher in the School, during the year ending 31st day of May 1865;

(2.) That he has given the following Students at least 25 lessons during the year, or since the last examination at which payment was claimed on their account, in each subject for which payment is claimed;

(3.) That the undermentioned students are artizans or operatives* in the receipt of weekly wages, supporting themselves by their own manual labour; or their children not earning their own livelihood.

Wm. Brown, Secretary.

John Jones, Two members of Committee.

I hereby certify that the following particulars are correct.

John Smith, Teacher.

NAMES OF PASSED ARTIZAN OR OPERATIVE STUDENTS.*

N.B.—The names of the students must be arranged alphabetically. After each student's name must be placed his several successes (if he has more than one); and in the last column the amount claimed on each success after making the proper deduction.

Surname.	Christian Name in full.	Age last Birthday.	Trade, or father's trade. (State which is given).	Position the last Examination Subject.	ate ation.	Highest Position in same Subject at any previous Examination.	Payment claimed.	
Adams, " Barber, Smith,	James, " John Wm. Henry. William,	22 " 14 12	Carpenter, " Butcher (f) Baker (f)	X. XIV. XIV. XI.	1st 2md Pass 1st 4th 1st	4th 2nd —	£ s. 5 0 1 0 0 10 0 10 2 0 5 0	

^{*} Should the Teacher have instructed any Students who may fairly be considered to belong to the industrial classes, but whose wages are paid at longer intervals than a week, or who do not support themselves by their own manual labour the claims on their account must be made by the Committee of the school on the form on page 3, when they will be considered on their merits.

SCIENCE FORM, No. 108.

Application from		Secretary of the Local
Committee for the Scien	nce School or Class at	
for payment of allowan	ace for duties connected v	with the School, and for
superintending the exam		•
	·	
Sir.		
•	o payment according to	the regulations of the
	for duties connected wi	
Besence Directory,	and for superint	ending the arrangements
for carrying out the exa	minations on	the following days
in May 186 , I reques	minations on t that the sum of L	may
be paid to me, being the		
Dates of Examination.	Dates of Examination.	Dates of Examination.
Dates of Frammation.	Daves VI HAMIIII awoll.	TABLES OF EXPERIMENTAL
•		
	T am Sin	
	I am, Sir,	1.2.10
777 - Cl A	1 Our	bedient Servant,
The Secretary,		
Science and Art D	epartment.	
		
CONDITIONS UND	ER WHICH APPARATUS,	INSTRUMENTS, BOOKS,
&C. MAY BE OB	TAINED BY SCIENCE TEACHER CERTIFICAT	SCHOOLS OR CLASSES
Public Schools	BACHER CERTIFICATES, MECHANICS' INSTITU	ED IN SCIENCE, TIN
		•
I. The Lords of the	Committee of Council or ion several applications	n Education, having had
masters of Mechanics'	and other Institutions.	for grants to be made to
them of Apparatus and	and other Institutions, I Illustrations, recommen	ded by the Science and

Art Department for teaching science, think it necessary to adopt some general principle which shall regulate the decisions of the Committee in

reference to such applications.

^{* £1} annually for furnishing the returns, &c. specified on Science Form No. 170, connected with any Science school or class, and £1 in addition for each day's examination held by the Committee to which he acts as Secretary.

† Apparatus not exceeding 10L in value may be obtained by poor Schools and Mechanics Institutes, not taught by a certificated teacher, under the same conditions, that is, the Department will aid them to the extent of 5L.

Their Lordships have already fully recognized the great importance of practical science to all classes of the community, in all relations of life. They are, therefore, desirous that the Science and Art Department should assist, as far as possible, in promoting the distribution of diagrams and apparatus as the means of accomplishing this object; but as the indiscriminate gift of these aids for instruction to all applicants might lead to abuse, it is necessary to require some guarantee that they will be duly appreciated, which the mere request to have them does not imply.

The principle which governs the whole proceedings of the Department in all its branches is to afford partial aid, and to encourage, but not supersede public exertions in promoting education in science. They have, therefore, resolved that the Department shall have the power to assist schools and classes taught by a certificated teacher in Mechanics' and other institutions in purchasing diagrams and apparatus for teaching science at a reduction of 50 per cent. on the net cost.

Lists of the scientific diagrams and apparatus prepared by the Department, according to conditions of the following Minute, may be obtained of the Secretary of the Science and Art Department, South Kensington, London, W. It should be distinctly understood that the aid of the Department in purchasing these articles at a reduced price, if above 101. in value, can be granted only to public schools and institutions when taught by a certificated teacher.

Minute of the 23rd March 1860.

"The Lords of the Committee of Council on Education desire to afford the greatest facilities to teachers of science and navigation schools in obtaining the best instruments, apparatus, &c., for giving instruction in science and navigation, towards the purchase of which the Science and Art Department is authorized to pay 50 per cent. of cost; and they consider that the fullest opportunities should be given to manufacturers in all parts of the Kingdom for supplying such apparatus, &c. At the same time it is necessary that the Science and Art Department should have some guarantee that the apparatus and instruments are of good quality, and moderate in price. My Lords have therefore laid down the following rules and conditions:—

- "1. Samples of all articles on the manufacturer's list are to be sent to the Educational Collection, South Kensington Museum, for exhibition, where they will be arranged separately, according to the science for which they are intended, so as to afford teachers and others facility in inspecting them and making a choice.
- "2. The manufacturer is to supply priced catalogues of such articles printed in demy 8vo., in order that the various catalogues may be bound up together and supplied when asked for.
- "3. The manufacturer is to guarantee that the articles exhibited are fair samples of those specified in the priced catalogue, and he must engage to take back any article supplied to schools which may be inferior to the standard."

Manufacturers willing to comply with these conditions are to make a statement to that effect, and to send lists of apparatus, instruments, books, &c. in the following sciences:—1. Practical plane and descriptive geometry, mechanical and machine drawing, and building construction; 2. Physics (mechanical and experimental); 3. Chemistry; 4. Geology and mineralogy; 5. Natural history (zoology and botany, vegetable and animal physiology); 6. Navigation and nautical astronomy, and physical

geography. If these lists and prices are such as can be approved of, the manufacturer will be informed, and as soon as possible on his fulfilling the conditions, his list will be inserted in the catalogue. The catalogue will undergo a revision at least once a year, when manufacturers may send any improved forms of apparatus, &c.

The selection of the manufacturer will lie wholly with the Committee of the school. On their demand being sanctioned, the manufacturer will receive instructions to supply the articles ppon his receiving the 50 per cent. due from the school.

On obtaining a receipt from the Committee of the school (which is included in the form of the requisition) that the articles have been received, the remaining 50 per cent. will be paid quarterly to the manufacturer by the Department.

2. Payments, including charge for packing, must be made in advance to the agents on receipt of the invoice. The goods to be sent at the risk of the purchaser.

All communications to be addressed to the Science and Art Department, South Kensington, London, W.

By Order of the Committee of Council on Education.

N.B.—Apparatus grants will in future be rigorously confined to articles of a permanent and non-destructible nature; hence no aid will be afforded in the purchase of breakable articles, such as glass retorts, test tubes, &c., or, indeed, generally in the purchase of articles to be used by the student as distinguished from those of a permanent and illustrative character which are required by the teacher in giving instruction in science.

Grants are only made in the purchase of one object of the same kind. Duplicates of apparatus, &c. are not allowed at the reduced rate.

SCIENCE FORM, No. 49.

FORM of REQUISITION which may be had on application to the Secretary, Science and Art Department.

The following Requisition for Aid in purchasing apparatus, &c., after being flled up as required, is to be transmitted to "The Secretary of the Science and Art Department, South Kensington, London. W."

	N.B.—It is to be understood that the Department has a lien on the apparatus furnished to public institutions to the amount of the public aid given in supp them; they cannot therefore be sold.	lying						
No. 1 appli-	1. REQUISITION for AID in purchasing apparatus, &c.							
cation to be	For the use of School or Institution	on (*)						
filled in by Requisition-	In the City or Town of (a).							
ist, with	In the County of Male Female.							
full par- ticulars.	Male Female							
	(a) Erase the Class. (b) Pupils (Artisansor Operatives) of the Sc Class. (c) Erase the Class.	ience						
	and (a) Scholars or Members of Poor School of chanics Institute.	r Me						
	Total.							
	I request the aid of the Department in obtaining from M—the apparatus, &c., named in the opposite page, and I undertake that the same sh kept and used in the above-mentioned (*) school or institution for which they been demanded. The address to which the parcel is to be sent is as follows:— To be forwarded to	all be						
	peratSignature of Requisition	ist.						
	Dated thisday of18							
No. 2 to be filled in by the Depart.	2. Requisition sent to M day of and authority given for the supply of Articles to the extent of	gent,						
	Net Sum							
	of which & will be paid by the Department, and & together the cost of packing, by the school or institution, previous to the goods applied. Assistant Secrets	being						
	C. Turning of antidog work to Descriptioning or any Jun Alda							
No. 3 to be filled in by	3. Invoice of articles sent to Requisitionist as under, this	_ day						
agent on transmis- sion of the	Articles (Retail Price) & Deduct as above,—							
invoice.	Aid by Department							
	Add, for packing							
	Total to be paid by Requisitionist							
Nos. 4 and 5 to be filled in by agent.	4. Amount £ received from schools this d	ay of						
	5. Examples forwarded as directed above, together with Requisition, this————————————————————————————————————							
No. 6 to be filled in by Requisition-	6. Examples as per invoice received, and *Requisition returned to Agent, this—day of————————————————————————————————————							
ist.	* It is requested this paper may be returned to the Agent in an entire state after examples have been received.	r the						

SCIENCE FORM, No. 91,

Rules for the Conduct of Science Examinations.

1. The following rules must be hung up in the examination room for the information of the candidates one week before the examination. They should all be carefully read by the members of the Committee. Those marked with an asterisk must be read aloud before the Committee and the candidates on each night immediately before the examination

begins.

2. A room or rooms of such a size that, when seated, the candidates shall be at least five feet apart, from centre to centre, must be provided

for the examination.

*3. All Diagrams, &c. must be removed from the walls of the examination room.

Ink and blotting paper must be provided.

5. If one room is used three of the Committee must be present during the whole of the examination, if more than one room then two of the Committee per room, t who must carefully watch the whole examination and see that candidates use no unfair means either by assisting one another or using books or notes. The members of the Committee can, if they wish it, relieve one another, so long as the correct number are always present.

6. The examination papers will be forwarded, under cover, to the Secretary of the Committee so as to be received by him on the morning

of the day before that fixed for the examination.

*7. The candidates must be seated at their places at 6.50 p.m. After this time no candidate shall be admitted except under very exceptional circumstances, and that only by express permission of the Committee and if no person who has seen the examination paper has left the room. No candidate may on any account be admitted after 7.30 p.m.

*8. The examination papers must be opened in the examination room in the presence of the Committee, at 6.55 p.m. No examination paper

may be taken from the room till after 8 p.m.

*9. When the candidates are seated and the papers given out, the Committee will see that the candidates commence by filling in their names, &c., where directed. All the worked papers must be collected at 10 p.m., initialed, put under cover, and sealed in the presence of the members of the Committee; and forwarded by the first post to the Secretary of the Science and Art Department.

* 10. Candidates must on no account bring anything with them into the examination room, I except pens and pencils. No scribbling paper, slates, or anything of that nature must be allowed. Arrangements must be made by which all books, note-books, &c., can be given up and left at the

* 11. Candidates must not on any pretence whatever speak to one another after the papers have been given out. If a candidate should require to ask a question, he will hold up his hand, when a member of the Committee will attend to him, but no question on the meaning of any portion of the examination paper must be asked or answered.

12. It may be of service to the Committee that the teacher of the

[†] When there are not more than three candidates it will not be necessary for more than two members of the Committee to be present at the examination.

‡ Except such as by the Time Table (Science Form, No. 90) are required.

§ It is absolutely necessary that nothing that can be passed from one candidate to another should be allowed. Bough work and calculations must be done on the supplied form, the back of each leaf of the form, i.e., pages 2, 4, 6, and 8, may be reserved for this purpose, the pen being drawn through to show that they are not for the examiner. But nothing must be torn off the form.

class should attend before the examination begins to assist in getting the candidates into their places, &c.; but from the peculiar character of the examination it is so very necessary that not the slightest opportunity for misconstruction should exist that it is evident that he should not be in the room after the examination papers are opened. Information of his having remained in the room after this will at once lead to the examination being declared null.†

*13. The examination papers being given out no candidate must be allowed to return after having once left the room. Ton a candidate

leaving the room his papers must be taken up.

* 14. At 10 p.m., precisely, all the candidates must cease working, and members of the Committee will collect their worked papers from them at their places. It will therefore be advisable to warn them ten minutes before the time. The papers will be initialed, by the Committee as directed, as they are received from each candidate, as a guarantee that each has been worked by him whose name, &c., it bears. Should a candidate have completed his work before 10 p.m. he may, by permission of the Committee, go away at once, after his worked paper has been taken by a member of the Committee.

* 15. Should a candidate break any of the foregoing rules, ask from or give information to another, or use unfair means of any description, he must be at once expelled the examination room, and his paper cancelled,

and the Committee will state on it the cause of his expulsion.

16. On these examinations depend large grants of public money. On their being fairly, honestly, and impartially carried out depends the continuance of the system. The Committees are intrusted with this duty. They will see, then, how necessary it is to be extremely careful in conducting them, and to insist on the foregoing rules being complied with to the letter. They are therefore required to sign and forward this form with each set of worked papers.

We, the undersigned, mem School or Class held at	bers of the Commi	ttee of the Science
hereby certify that we were	held in the	
on the evening of thepapers were worked in our pres been strictly complied with.		
Dated this	day of	186 `.
Signature		Time Present.
**************************************	······································	

‡ It will, therefore, be desirable to make some arrangement for the candidates to retire within the room.

[†] Should the teacher of the class wish to compete at this examination for the Royal Exhibitions, he must apply specially to the Committee for permission, so that they may arrange to have a table for him close to their own seats, and not with the other candidates.

SYLLABUS OF THE SUBJECTS IN WHICH CERTIFI-CATES AS TEACHERS OF SCIENCE ARE GIVEN BY THE DEPARTMENT OF SCIENCE AND ART.

THE following Syllabus has been prepared in order to afford candidates for certificates as teachers of Science, some guide to their reading; but it must be understood that the questions in the examination need not

necessarily be on the specific points enumerated.

The examination is by paper, but oral examination may be resorted to, and satisfactory evidence may be required of the teacher's power of giving information to a class. The groups are divided as shown, the examination in each subject being distinct, so that candidates may, if they desire it, take a certificate only in one subject of a group. Mention is made of text-books solely to afford a candidate some assistance in selection and ageneral idea of the scope of the examination, and not at all to confine his reading to those works or to assert that they are the best on the subjects they treat of.

Any certificate obtained at the examination may be raised, by reexamination, in the next or any following November to a higher grade.

A Course of Lectures as detailed below, on "Preparation for obtaining "Science Certificates and the Method of teaching a Science Class," has been delivered by direction of the Lords of the Committee of Council on Education. The lectures may be purchased, price 2d. each, at the book stall, South Kensington Museum, or on application by letter, enclosing postage stamps, to the Secretary, Department of Science and Art, South Kensington, London, W.

Group I. - Geometrical Drawing, &c. Prof. T. Bradley.

", II. - Mechanical Physics - Rev. B. M. Cowie, M.A. - Prof. Tyndall, F.R.S.

", IV. - Chemistry - - - Prof. Hofmann, F.R.S.
", V. - Geology - - - Prof. Ramsay, F.R.S.

Mineralogy, &c. - Prof.W. W. Smyth, M.A., F.R.S.

VI. - Zoology - - - Prof. Huxley, F.R.S.

",, VII. Botany - - - Edwin Lankester, M.D., F.R.S.
Navigation and Nautical J. Riddle, F.R.A.S.
Astronomy.

Physical Geography - Dr. G. Kinkel, F.R.G.S.

A Second Course has been delivered, of which the following have been published:—

Lecture I. - Vegetable Physio- Edwin Lankester, M.D., 3rd February. logy and Econo- F.R.S. mic Botany.

Lecture II. Mechanical Physics Rev. B. M. Cowie, B.D. 10th February. Lecture IV. Mining - W. W. Smyth, M.A., 24th February. F.R.S.

SYLLABUS.

A teacher will not receive any payments for Subjects II. or III. until he is certificated in I.

Subject I.—Practical Plane, and Descriptive Geometry.

Practical Geometry, plane and solid; required by architects, engineers, mechanists, shipbuilders, and others employed in arts of construction.

The candidate is expected to have acquired readiness in the use of the usual drawing instruments and materials, to be skilful in drawing lines and circles in Indian ink, plain or dotted, of different degrees of fineness; drawing parallel equi-distant lines, at least six inches long, and from five to twenty or thirty in an inch; drawing from ten to thirty lines, passing through one point and forming equal angles; dividing by trial lines and arcs into any number of equal parts. He should also be able to mend his drawing pens and other instruments, and to verify his rulers, &c.

Constructions in Plane Geometry.

 To draw lines through given points, in every position, either parallel, perpendicular to, or to form any proposed oblique angle, with given lines.

The use and construction of the protractor, and of the "scale of chords" for these purposes, should be understood, and the deduction of certain angles from the direct division of the circle.

To draw circles or arcs, through given points, to touch given lines or circles, and, conversely, lines to touch circles.

Required in drawing framework for machinery, architectural designs, ornamentation, &c.

The principles of drawing symmetrical forms by means of co-ordinates to the axis of symmetry.

This is the basis of all drawing, of all objects of construction, which are universally symmetrical, not only in architecture, civil and naval, but in machinery and engineering works of all kinds.

 Constructions of figures similar to given rectilinear or mixtilinear figures.

Here the construction and use of "scales" plain and comparative, should be thoroughly understood and explained, and the principles of the diagonal and the versier subdivision. Also the mode of reducing or enlarging drawings by means of similar rectangles, termed squaring a drawing. The use of the sector and of proportional compasses, and of the pentagraph and eidograph, in facilitating copying should be known.

- To construct rectilinear figures similar to given ones, but with a proposed area.
- 6. To determine by construction numerical quantities such as \sqrt{m} ; $\sqrt{\frac{a^2+b^2}{m}}$; $\sqrt{a^2+b^2}$, &c.

7. To construct a triangle, any three parts being given.

Used in levelling, surveying, and the determination of heights and distances. Great accuracy, neatness, and distinctness of construction, will be insisted on: Geometrical drawing is valueless unless it possesses these requisites. A few illustrations of constructions on the ground, by means of a "chain," pins and cords, necessary in surveying, and "setting out" buildings and earthworks, may be added to the course, as well as the solution of a few elementary problems by means of the compasses alone.

8. The delineation of a few of the curve lines required in the arts, such as the ellipse, cycloidal curves, the involute and sinusoid, with the graphical method of determining their tangents and normals.

Required in designing elliptic arches, oblique bridges, teeth of wheels, cam-work, screws, &c.

- Practice in tinting and shading with Indian ink, so as to express curved surfaces and shadows.
- For the preceding part of the course, a fair knowledge of the first six books of Euclid is strongly enjoined, some acquaintance also with trigonometry will be of service, as without such previous knowledge, the learner is simply copying what is set before him, and cannot attain the highest skill in drawing.

Constructions in Solid Geometry.

(Descriptive Geometry.)

Preceded by explanations of the term projection, and of the necessity for it, in order to express graphically, on a surface, solids of any kind; the distinction between orthographic and perspective projections; their uses, and general principles which are the foundation of their practical application.

Orthographic Projection.

- Why the projections, of any solid consisting of a combination of geometric forms, on two or three co-ordinate planes are necessary to show the form and dimensions of that solid.
- Meaning of the terms plan, elevation, profile, section. The principle of the representation of surfaces by the projections of their generators, or of equi-distant horizontal sections termed contours. The direction and inclination of an indefinitely extended plane given by its contours, or by its traces on any two co-ordinate planes.
- These principles should be quite familiar to the candidate, and will be tested by making him draw plans, elevations, and sections of simple solids, as prisms, pyramids, cones, spheres, cylinders, and of symmetrical solids formed by their combinations.
- A few of the problems relating to points, lines, planes, and curved surfaces, will be required, as—
- 1. To draw lines and planes parallel or perpendicular to each other, to contain given points or lines, and the limits of the possibility of solution of any problem should always be understood.
- The preceding constructions combined and applied to determine by their projections the simple solids before mentioned, when they are not symmetrically situated with respect to the supposed planes of projection.

3. Applications to the intersections of surfaces, and of the development of such as admit of it.

> This may be considered the most important part of descriptive geometry to the artizan, as it is required in all arts of construction. The mason, carpenter, and shipwright, workers in tin-plate, boiler makers, &c., would all be benefited by a knowledge of it.

This application has been termed Stereotomy, and better and more

significantly in French, "Coupe de pierres."

Much practical knowledge of the subject, arising from their pursuits, is possessed by workmen, while the want of a scientific knowledge of it compels architects, engineers, and their drawing clerks to leave to the workmen the execution of their conceptions which they cannot themselves design,

4. The solution by construction of the spherical triangle from any three given parts, is mentioned.

> As important to masters, mates, and others engaged in any kind of astronomical calculations.

Isometric Projection.

Is usefully employed in the representation of works chiefly of a rectangular form, such as timber framing, canal-locks, and many parts of machinery; its use is much increasing: it is readily understood, and can be practised by anyone who has gone through the first two articles of this section.

Perspective Projection.

May be taken up, but will not be insisted on as it is rarely used except by architects to represent buildings (not yet executed), as they would appear to the eye at any spot from which they could be viewed, and the power of applying it for this purpose is possessed by many who know little of the really easier subject of descriptive geometry; but as its application by the architect must be subordinated to artistic taste, this consideration excludes it, in some measure, from a purely geometrical course.

No one, however, can be considered a scientific draughtsman unless he can apply perspective projection to the projection of shadows, the projections of the sphere, the constructions of maps and dials, and

some other uses.

For the second division of this course, in addition to what was before indicated, a competent knowledge of the theorems relating to the line and plane (Euclid, Book XI.), and an acquaintance with the leading properties of the conic sections, the geometry of the sphere, and some spherical trigonometry is important, it cannot be too urgently recommended to all persons wishing to master this course. to study such works as "Geometry, Plane, Solid, and Spherical" of the Library of Useful Knowledge, and Mr. Bell's, in Chambers' Educational Course.

Geometry, Plain, Solid, and Spherical (Library of Useful Knowledge) is especially recommended as a work to be studied on Theoretical Geometry. Text-Books for Practical Plane Geometry.—Bradley's Geometrical Drawing: Burchett's Practical Geometry: Practical Geometry, Linear Perspective and Projection (Library of Useful Knowledge).

For Descriptive Geometry.—Bradley's Geometrical Drawing; Hall's Elements of Descriptive Geometry for Students in Engineering.—Heather's Descriptive Geometry. Also the following French Works, which are mentioned in consequence of the great deficiency of English Works on Geometrical Drawing.—Elémens de Géométrie Descriptive, par S. F. Lacroix; Traité de Géométrie Descriptive, par Levebure de Fourcy; Nouveau Cours raisonné de Dessin Industriel, par Armengaud, aîné, et Armengaud, jeune, et Amouroux; Bardin's Works on Descriptive Geometry.

Subject II.—Mechanical and Machine Drawing.

- The candidates in Subjects II. and III. will, some time before the examination, have specifications of subjects given to them, of which they will be required to prepare drawings before the examination. These drawings must be bond fide their own. The candidates may be examined on them, and if the results be satisfactory, they will count towards their certificates, but they will only be taken into consideration when it is clearly seen from the regular examination that the candidate is qualified for a certificate.
- The application of the foregoing Subject I. to the drawing of machinery, in which great accuracy and neatness of drawing will be insisted on.
- The candidate will be required to take measurements with calipers, &c., and to make drawings, elevations, and sections of a simple machine, or of parts of one, set before him. Also to draw a portion of a machine from written dimensions and description. He will be required to have sufficient knowledge of the principles of machinery, gearing, &c., to be able to make working drawings of a machine or portions of a machine from a rough sketch, applying the power to the greatest advantage, and obtaining such power or changes of motion as are required. In fine, such knowledge and readiness as would be required of a good draughtsman in an engineer's office.

Subject III.—Building Construction, or Naval Architecture.

(See previous Subject.)

- The candidate will be required to possess sufficient knowledge of construction—(1) to apply the various materials used in building to their greatest advantage; (2) to be able to make detail and working drawings showing a knowledge of the methods of construction and the framing of ordinary roofs, bridges, &c., whether of wood, iron, or masonry; (3) to frame estimates and take out quantities.
- Neatness, accuracy, and facility in drawing will be insisted on, and the general requirements in this Subject will be such as would be possessed by a good draughtsman in an architect or builder's office, with a slight scientific knowledge for the proper application of the materials he is required to work with.
- N.B.—Naval Architecture may be taken instead of Building Construction; the same description of attainments will be required.

Subject IV.—Elementary Mathematics.

1. Arithmetic generally.

Geometry.—The properties of lines, triangles, rectilinear figures, the
circle; properties of similar figures; proportion of figures; inscribed
and circumscribed polygons. The questions will have reference to
Euclid's elements; but a sound knowledge of Geometry obtained
from any source will be accepted.

3. Algebra.—Definitions. Addition. Subtraction. Multiplication. Division. Greatest common measure. Least common multiple. Theory of indices (integral). Involution. Evolution. Simple

equations, and problems producing them. Fractions. Quadratic equations, and problems producing them. Ratio. Proportion. Variation. Arithmetical, geometrical, and harmonical Progressions, Proportion. Permutations, and Combinations. Binomial theorem for a positive

integral index.

4. Plane Trigonometry. - Definitions. Conversion of degrees and their subdivisions into grades, and their subdivisions, and vice versa. Angular and circular measures of degrees and their relation. The goniometric functions of angles and the conversion of one into another. The arithmetical values of the goniometric functions of 90°, 45°, 60°, 30°, 180°, 120°, 150°, &c. The meaning of contrariety of signs in trigonometry. Tracing of the goniometric functions in magnitude and algebraic sign through the four quadrants and when an angle is indefinitely increased.

Formulæ for multiplication and division of angles, viz., sine, cosine, tangent, &c., of $(A \pm B)$, 2A, 3A, $\frac{A}{2}$, and $\frac{A}{3}$. Also of A and B in

terms of
$$\frac{A+B}{2}$$
 and $\frac{A-B}{2}$.

Logarithms.—Definition. Multiplication, Division, Involution and Evolution by logs. The use of logarithmic tables. Tables of proportional parts for numbers and angles. Modulus. Construction of logarithmic tables, and of tables of logarithmic sines, cosines, &c.

Triangles.—Formulæ for cosine of an angle of a triangle in terms of its sides. The relation between sines of angles and the opposite sides; sine, cosine, tangent, &c., of half an angle of a triangle in terms of sides, and of the sine of an angle. Area of a triangle. Solution of triangles. Diameters of circles inscribed in and circumscribed about a given triangle. Areas of regular polygons inscribed in and circumscribed about a given circle. Area of a circle. Description and use of vernier and theodolite and sextant (generally). Heights and distances of inaccessible objects.

For students to obtain a 5th class, a competent knowledge of the following alone will be required:-

(1.) Geometry. The first book of Euclid.

(2.) Algebra, to simple equations and problems (inclusive).

(3.) Plane trigonometry. The more elementary portions, including use of logarithms.

To obtain a 4th class :-

(1.) Geometry. The first three books of Euclid.

(2.) Algebra, to quadratic equations.

(3.) Plane trigonometry as far as solution of triangles, inclusive.

And for third, second, and first class Queen's prizes the remaining

portion of the above subjects.

Subject V.-Higher Mathematics.

1. Algebra.—Surds. Theory of indices (fractional and negative). Binomial theorem generally. Multinomial theorem. Exponential theorem. Indeterminate equations and problems. Indeterminate coefficients. Reversion of series. Properties of numbers.

2. Plane Trigonometry.—De Moivre's theorem and the expansion of

sine, cosine, and tangent in terms of the angle.

Spherical Trigonometry.—Definitions and fundamental propositions. Polar or supplemental triangle and its properties. Area of a spherical triangle. Spherical excess.

Fundamental formulæ expressing the relations of the sides and angles of a spherical triangle.

Napier's analogies.

Solution of right-angled spherical triangles and of oblique angled triangles.

Mensuration.—Trapeziums. Regular plane rectilinear figures. Irregular plane curvilinear figures (Simpson's or Stirling's Rules). Volumes and surfaces of Parallelopipeds, Pyramids, Cylinders, Cones, and Spheres.

Differential and Integral Calculus.—Definitions. Differential of elementary functions, including circular and logarithmic functions. Vanishing fractions. Maxima and minima of one independent variable. Tangents and normals of curves. Differential coefficients of Areas, Arcs, Volumes and surfaces of solids of revolution.

Integration of elementary functions. Integration by parts. Rational fractions. Integration between limits. Areas and lengths of simple curves. Volumes and surfaces of solids of revolution.

Subject VI.—Mechanics as a Science, or Theoretical Mechanics.

Statics. Composition and resolution of forces. Forces acting on a point—on a rigid body. Parallel forces. Centre of gravity. Theory of moments or couples. Principle of virtual velocities. The mechanical powers. Friction. Equilibrium of roofs and arches.

Dynamics. Laws of motion. Uniformly accelerated motion. Motion by gravity Variable forces. Projectiles. Centrifugal force. Motion on inclined planes—on curves. Pendulums. Motion of rigid bodies, free or constrained. Moment of Inertia. Centre of oscillation—of percussion. Motion of flexible bodies, such as a musical string.

Hydrostatics, Hydrodynamics, and Pneumatics. Mechanical properties of liquids. Law of pressure. Centre of pressure. Laws of floating bodies. Capillary attraction. Laws of fluid motion, through open channels, closed pipes, or orifices.

Mechanical properties of elastic fluids. Theory of barometers. Connexion between pressure, temperature, and volume. Specific heat. Weight of atmosphere. Use of barometer in calculating heights.

In this subject the candidate will have to show a mathematical knowledge of the laws of Mechanics, and must be able to prove from

first principles the principal theorems.

The books recommended for study are—Whewell's Elements of Mechanics, or Snowball's; Moseley's Engineering Architecture; Natural Philosophy, by Dr. Golding Bird and Mr. Brooke; Goodwin's Elementary Course.

Subject VII.—Mechanics as an Art, or Applied Mechanics.

General principles of mechanism. Elementary combinations. When the connexion is by rolling contact, sliding contact, wrapping connectors or linkwork, with constant or varying velocity ratio, and constant or varying directional relation.

Machines of ordinary occurrence must be thoroughly understood and particular parts to be described and drawn: such as cranes; lathes; drills: planing, punching, boring, shaping, and slotting machines. Spinning and weaving machinery. Mode of calculating power of machinery. Dynamometers, indicators, &c.

Materials. The general properties of materials. Elasticity. Weight. Specific weight. Mechanical work. Work done by pressure, by

impact, by expansion of elastic gases and steam, by animal muscular effort.

Resistance to expansion, to compression, to rupture. Friction of solids. Its importance in construction. Resistance of fluids to bodies moving within them. Adaptation of form and material for maximum resistance. Beams of greatest strength. Construction of roofs, arches, stone and timber bridges, suspension bridges, and tubular girders.

Hydrostatics, Hydrodynamics, and Pneumatics. Pressure on floodgates; locks; water-wheels; turbines; water-pressure engines; breakwaters. Hydrometers. The syphon. Hydraulic ram. Pumps. Diving bell. Condenser. Windmills. Steam-engines, stationary, marine, locomotive. The steam hammer. Water supply to towns.

Theory of tides, in the open sea, and in rivers.

In this subject the candidate will be expected to show how the principles are applied in actual practice: he will be expected to show by clear well-drawn sketches, his acquaintance with parts of machines.

The candidate will have tools and models put before him, with some of which he must show he is familiar, and that he can explain their use

and construction.

Books recommended:—Willis's Mechanism; Baker's Elements of Mechanism; the books in Weale's Series which treat on the subjects specified. Twisden's Practical Mechanics; Goodeve's Elements of Mechanism.

Subject VIII.—Acoustics, Light, and Heat.

Acoustics.

The candidate ought to know the manner in which sound originates, and is propagated; its velocity in different media, and how its velocity

through air is affected by density and temperature.

He ought to know the origin of musical sounds; of pitch; of harmony and discord; to commit to memory the rates of vibration of the several notes of the gamut; to be able to make sonorous vibrations visible by means of glass plates and membranes; to calculate the length of sonorous waves, and to determine practically the number of vibrations due to any particular note. He ought therefore to understand the construction and use of the Syren.

He ought to be able to describe and illustrate the condition of a vibrating string, or column of air at its nodal points and ventral segments and

to explain echos and resonance.

Light.

The candidate ought to know how its velocity was first determined from

observations upon Jupiter's satellites.

He ought to be able to devise a simple means of exhibiting both the reflection and refraction of light; to be able to state the laws of both; to explain what is meant by total reflection; and to apply it to the explanation of the Mirage of the Desert, the Phantom Ship, and other similar phenomena.

He ought to be able to explain why the image in a plane mirror must appear as far behind the mirror as the object is in front of it; why a stick appears bent when dipped obliquely into water; and why the bottom of a river or lake, or of a basin which holds water, appears to

be nearer to the surface than it really is.

He ought to be able to determine the positions of the foci of spherical mirrors, both concave and convex; to describe the characters of their images, whether erect or inverted; magnified or reduced; and to do the same for convergent and divergent lenses.

He ought to know the construction of the human eye; the conditions of distinct vision, the use of spectacles; and to be able to describe a simple form of the reflecting and refracting telescope and of the microscope.

He ought to know the constitution of light; to be able to describe the spectrum produced by refraction with a prism; to explain the origin

of colours, and to give a clear explanation of the rainbow.

Heat.

The candidate ought to be able to describe the construction and graduation of an ordinary mercurial thermometer; to understand the scales of Fahrenheit, Celsius, and Reaumur.

He ought to have clear ideas of conduction and radiation; to be able to devise some simple means whereby the conductive and radiative powers of different bodies may be determined; to explain fully the formation of dew, and to state the conditions favourable to its production.

He ought to know the effect of heat upon the volumes of bodies; to know what is meant by the coefficient of expansion, and how it may be determined; to give illustrations of the enormous power of heat in producing expansion; to state exceptional cases; to know the manner in which heat is propagated through liquids and gases, as distinguished from ordinary conduction; and to be able to combine two metals possessing different coefficients of expansion, so as to form a compensating pendulum.

He ought to know the meaning of latent heat and of specific heat, and to illustrate both by reference to ice, water, and steam; he ought to be able to show the influence of the high specific heat of water upon

an island climate.

He ought to know the strict physical meaning of ebullition; and the influence of pressure upon the boiling points of liquids; he ought to have a general knowledge of the origin of winds and clouds, and to be able to explain the fact that the rain-fall upon the south-west side of a mountain chain in England and Ireland is much more copious than on the north-east side.

Subject IX.-Magnetism and Electricity.

Magnetism.

The candidate ought to know the action of one loadstone upon another which is freely suspended, or set afloat upon a liquid; he must have a perfectly clear notion of magnetic polarity, and of the action of magnetic poles upon each other.

He must know the difference between the action of magnetised and unmagnetised steel upon a magnetic needle; also the difference between soft iron and hard steel, with regard to their acceptance and

retention of the magnetic condition; (coercive force).

He must be able clearly to state the condition of a mass of soft iron when under the influence of a magnet, and in virtue of which condi-

tion the iron is attracted; (magnetic induction).

He must be able to describe the action of the earth upon a magnetic needle; must know the meaning of declination, inclination or dip, and of secular and diurnal variation; the action of the earth upon a bar of soft iron according as it is held in the direction of the dip or at right angles to this direction; finally, the effect of percussion in rendering the condition assumed by the bar of soft iron a permanent one.

He ought to be able to compare accurately the strength of one magnet with that of another, and to state how the relative intensity of the earth's magnetism at two points of its surface may be ascertained.

Frictional Electricity.

The candidate ought to know various simple ways of exciting electricity to be clearly informed as to the duplex character of the force; to know the condition of the rubber as well as that of the body rubbed; and to be conversant with various forms of electroscopes and electrometers.

He ought to know the foundation of the terms vitreous and resinous, positive and negative; to be able to illustrate the action of two electrified bodies upon each other; and to tell at once whether a body is

positively or negatively charged.

He ought to have a clear knowledge of electric conduction, insulation, and induction; and be able to explain the state of a neutral conductor when acted upon by an electrified body; he ought to be able to prove, experimentally, that though we cannot by breaking a magnet obtain two halves each with a single pole, we can by breaking an electrified body obtain two halves each charged with a single electricity.

He ought to be able to explain the influence of points and flames when attached to an electrified conductor; and to describe the action of

lightning conductors.

He ought to be able to describe the electric machine, and the electrophorus; and to explain the action of the condenser and of the Leyden jar.

He ought to be able to state the principal effects of the electric discharge; to state the atmospheric conditions necessary to the production of a thunderstorm; and to give a clear account of the so-called return stroke.

Voltaic Electricity.

The candidate ought to be able to state precisely how voltaic electricity may be generated; to describe Volta's pile, and his crown of cups;

and also the batteries of Daniell, Grove, and Bunsen.

He must have a clear conception of what is meant by the direction of an electric current; and be able to illustrate in the fullest manner the action of a current upon a freely suspended magnetic needle. Given the direction of the current, he must be able to state how the needle moves; given the movement of the needle, he must be able to infer from it the direction of the current.

He must be able to describe fully the action of a current upon soft iron; and to infer from the direction of the current the nature and position

of the magnetic poles, which it excites.

He must be well acquainted with the chemical reactions which take place both in the batteries, mentioned above, and also in other liquids

through which the current may be sent.

He must be able to measure the strength of an electric current, and he is strongly recommended to master thoroughly the law of Ohm, regarding the mutual relations of electromotive force, resistance, and strength of current.

He ought to be acquainted with the so-called polarisation of metallic plates between which a current passes through a liquid, and to show

how this is avoided in Grove's battery.

He ought to be able to give a clear description of some one form of the

electric telegraph.

He ought to be acquainted with the physiological effects, and with those of light and heat produced by the voltaic current; and to show the dependence of the heat on the strength of the current, and on the resistance which it encounters.

It would also be well to master as much of the phenomena of induced currents as would enable the candidate to explain the action of the galvanizing apparatus used by medical men.

Norz.—This candidate will perceive that this list is long because the objects to which he is to devote his attention are separately specified. Definition is thus given to his studies and their precise scope marked out for him. He is recommended to repeat with his own hands, as far as it is in his power to do so, the experiments which he finds described in good handbooks of Natural Philosophy; this will give a certainty to his knowledge and an interest to his pursuits which mere reading can never confer. The first requisite demanded of him on his examination will be that, however small his knowledge, it shall be well digested and sound.

'Text-Books:—Lardner's Handbook of Natural Philosophy; Natural Philosophy, by Dr. Golding Bird and Mr. Brooke.

Subject M.-Inorganic Chemistry.

The general principles of chemical philosophy. Laws of combination. Combining weights and chemical equivalents. Combining volumes. Chemical symbols and their use in the explanation of chemical changes. The atomic theory.

The non-metallic elements: Oxygen. Combustion.

Hydrogen. Water. Chemical composition and properties. Adaptation for domestic purposes. Hardness, permanent and temporary.

Nitrogen. Nitrous oxide, nitric oxide. Nitric acid. Nitrification.
Ammonia.

Carbon. Process of carbonization. Carbonic oxide. Carbonic acid. Marsh gas. Oleflant gas. Manufacture of coal gas.

Sulphur. Sulphurous acid, sulphuric acid. Sulphuretted hydrogen. Bisulphide of carbon.

Chlorine. Hypochlorous acid. Bleaching agents and theory of bleaching. Chloric acid and perchloric acid. Chloride of nitrogen. Chlorides of carbon.

Bromine. Bromic acid and hydrobromic acid.

Iodine. Iodic acid, periodic acid, and hydriodic acid.

Fluorine. Hydrofluoric acid.

Phosphorus. Hypophosphorous acid, phosphorous acid. The several modifications of phosphoric acid: ordinary phosphoric, pyrophosphoric, and metaphosphoric acids. Theory of polybasic acids. Phosphoretted hydrogen. Chlorides of phosphorus. Manufacture of matches.

Boron and boracic acid.
Silicium and silicic acid.

The metals: Potassium. Manufacture of nitre. Manufacture of gunpowder. Theory of the action of gunpowder. Sodium. Manufacture of carbonate of soda.

Barium. Strontium. Calcium. Mortars.

Magnesium, Aluminium. Manufacture of glass and porcelain.

Manganese. Iron. Composition and properties of cast iron, wrought iron, and steel.

Cobalt. Nickel. Chromium. Zinc. Cadmium. Copper. Lead. Manufacture of white lead.

Bismuth. Mercury. Tin. Arsenic. Course of analysis in cases of poisoning.

Antimony. Silver. Gold, and platinum. Their principal compounds with the non-metallic elements.

Outline of qualitative analysis. Reactions of the principal mineral acids and bases. Course pursued in the application of these reactions to the analysis of a mixture of several acids and bases.

The following is the list of Apparatus and Re-agents with which Candidates make their analysis at the examination:—

APPARATUS.

Test tubes and stand.
Metal filter stand.
Wash bottle containing
distilled water.
Spirit lamp.
Black blowpipe.
Charcoal for blowpipe
experiments.

Iron spoon.
Tongs.
Pestle and mortar.
Porcelain dishes.
Watch glasses.
Porcelain crucible.
Triangles.
Test tube cleaner.

Platinum wire and foil. Funnels.
Cut filters.
Sulphuretted hydrogen apparatus.
Platinum crucible.
Herapath's blowpipe.
Stirring rods.

RE-AGENTS.

Sulphuric acid.
Hydrochloric acid.
Nitric acid.
Hydrosulphuric acid.
Potassa.
Ammonia.
Chloride of ammonium.
Sulphide of ammonium.
Carbonate of ammonium.

In the liquid state.
Phosphate of sodium.
Chloride of barium.
Chloride of calcium.
Lime water.
Sulphate of calcium.
Sulphate of potassium.
Sulphate of magnesium.
Chromate of potassium.
Oxalic acid.
Tartaric acid.
In the solid state.

Acetic acid.
Hydrofluosilicic acid.
Oxalate of ammonium.
Acetate of lead.
Sesquichloride of iron.
Ferrocyanide of potassium.
Chloride of platinum.
Nitrate of silver.

Carbonate of sodium.
Nitrate of potassium.
Cyanide of potassium.

Borax. Lime. Sulphate of iron. Blue and red litmus paper.

Subject XI .- Organic Chemistry.

Ultimate analysis of organic bodies. Calculation of an empirical formula. Methods of controlling an empirical formula. Determination of the equivalents of organic acids and bases, examination of products of decomposition, determination of the vapour-density of volatile bodies. Law of substitution.

The chemical history of the Cyanogen group. Cyanogen. Hydrocyanic acid. Cyanic acid and urea. Fulminates. Cyanuric acid. Sulpho-

cyanic acid. Chlorides of cyanogen.

Amylaceous and saccharine substances. Fermentation. Alcohol, and its homologues. Ethers, simple and mixed. Oxidation of alcohol, Aldehyde and acetic acid, and their homologues. Anhydrides, simple and mixed. Compound ethers. Diatomic alcohols and their acids. Glycol and oxalic acid. Triatomic alcohols. Glycerine. Fatty and oily bodies.

Ammonia and its derivatives. Amides and amines: their classification.

Examples of natural alkaloids.

Principal colouring matters. Indigo and its derivatives. Examples of products formed by destructive distillation.

The chief constituents of the vegetable and animal organism, fibrin, albumen, casein, &c.

The chemical principles of agriculture.

The chemical principles of the process of nutrition and respiration in

the animal organism.

Text-books. — Graham's Elements of Chemistry, Miller's System of Chemistry, Fownes' Manual of Chemistry, Gregory's Outlines of Chemistry, Abel and Bloxam's Handbook of Chemistry, Galloway's Qualitative Analysis.

Subject XII. -Geology.

1. The division of rocks into three great classes, aqueous, igneous, and metamorphic.

2. The mode of formation of stratified rocks,—marine strata—delta formations - freshwater beds, - the sign by which you can distinguish

3. The mode of occurrence of igneous rocks, ashes, lavas, and dykes.

4. Volcanoes and volcanic phenomena.

5. The theory of central heat.

6. Elevation and depression of land.

7. The ordinary mineral substances that enter into the composition of rocks.

8. Fossilization of organic bodies.

9. Table of geological formations, including those larger divisions absent in Britain.

10. Theory of metamorphism of rocks.

British Strata.

1. Description of the Cambrian strata and Silurian strata, their lithological characters, disturbances and chief fossils.

2. Description of the old red sandstone and Devonian rocks, character and fossils. Origin of cleavage. Slate and slate quarries, buildingstones, limestones, and marbles.

3. The carboniferous limestone and coal measures. Character, fossils, and mode of formation. Origin of the coal of the coal-measures. and its mode of occurrence. Mode of occurrence of the ironstone of the coal measures. Various kinds of coal, and the relation of anthracite coal to disturbance of strata. Lime quarries, marbles, and building stones. Clay pits and potteries of the carboniferous Fire clay. Alum shale. strata.

4. The Permian rocks. Their strategraphical relations to the underlying strata, composition of rocks, fossils, and building-stones.

5. The new red sandstone (or Trias), its subdivisions, fossils, buildingstones, sand pits, rock salt, and brine springs. 6. The Lias. Its subdivisions, chief fossils, building-stones, and other

hydraulic limestones, and clay pits.

7. Oolitic rocks. Subdivisions, leading fossils, building-stones. Limestones. Clay pits, and other economic products.

8. The Purbeck and Wealden strata. Origin, subdivisions, chief fossils, building-stones, and marbles. Ironstones and limestones. Clay pits.

9. Cretaceous rocks. Subdivisions, lithological characters, fossils, building stone of lower greensand. Gault, its phosphatic nodules and general uses. Upper greensand, chalk, &c. Building stones. Origin and uses of chalk-flints.

Subdivisions, alternation of marine 10. Eccene, or older Tertiary beds. and freshwater beds, chief fossils, limestones and building stones,

clays for bricks and potteries.

11. Crag. Its subdivisions, chief fossils, phosphatic remains.

12. Disturbance and denudation of strata. 13. Unconformities, faults, and fractures.

14. The causes of gaps in the succession of strata, or of breaks in the succession of life in time.

15. Water-bearing strata, and underground drainage. Artesian and other wells.

16. British rocks in which ores of metal are found, and the general mode of occurrence of these ores in beds or lodes.

17. The rules that ought to guide the miner in sinking for coal and other minerals, when the beds in which they lie are concealed by over-lying and unconformable strata.

18. The occurrence of stream tin, gold, &c., in superficial detritus.

19. The chief differences in the nature and mode of occurrence of various formations in areas widely separated from each other.

Text-books.—Lyell's Principles of Geology; Lyell's Elements of Geology; Phillips' Manual of Geology; Jukes' Manual of Geology; Page's Introductory Text-Book; Page's Advanced Text-Book.

Subject XIII .- Mineralogy.

A. Instruction in this subject should commence with a distinct understanding of the characters by which minerals, properly so called, are to be distinguished from other inorganic substances, and of the position of this science in relation to the collateral sciences of

physics, chemistry, and geology.

B. Crystallography, as the essential means of appreciating the forms naturally assumed by almost all inorganic bodies, must commence with the needful geometrical definitions, proceed to the grouping of the various crystalline forms into systems, consider the laws by which the derivation of one form from another within the limits of the same system is determined, and explain the combination of various simple forms in the faces exhibited by compound crystals. It is also important to study the deviations from regularity which are commonly presented in nature, and the methods of measuring those elements which remain constant.

c. The various kinds of aggregation exhibited by crystalline substances are also to be considered, especially with reference to masses of the

useful minerals, and of crystalline rocks.

D. Next in order will follow the other physical characters of minerals; 1st, in relation to their substance, as cleavage, fracture, hardness, and specific gravity: 2ndly, in relation to the effects of light, as transparency, refraction, lustre, and colour; 3rdly, as to their electric and magnetic properties.

E. The chemical characters of minerals, and the most convenient modes of testing them; 1st, by aid of the blowpipe; 2ndly, by the

moist way.

P. Pseudomorphism, or the remarkable phenomena presented by minerals which have the composition of one mineral coupled with the form

of another.

G. The physiography or systematic description of minerals. This last division should include all the more remarkable varieties as well as species, and should take especial note of the modes and places of occurrence, as well as of the association of particular groups of minerals in certain veins or formations.

As text-books may be recommended—

Professor Ansted's Elementary Course of Mineralogy and Geology. London, 1856.

Nicol's Elements of Mineralogy. Edinburgh, 1858.

Dana's Manual of Mineralogy, 1851.

Bristow's Dictionary of Minerals. Longman & Co. 1861.

For more advanced students-

Brooke and Miller's Mineralogy. London, Longman, 1852. Rev. W. Mitchell, in Orr's "Circle of the On Crystallography. Sciences." London, 1856.

Dana's System of Mineralogy. 4th edition. Putnam, 1854.

Naumann's Mineralogie. Leipzig. Williams and Norgate, London.

Breithaupt's Paragenesis der Mineralien. Freiberg, 1849. Haidinger's Handbuch der Mineralogie. Vienna, 1845.

When it is intended to teach this subject with special reference to the

practical working of minerals, the physiographical part will be occupied more particularly with certain of the useful species and their associated substances, and the following works may be consulted:—

W. J. Henwood on the Metalliferous Deposits of Cornwall and Devon, 1843.

Bischof, Chemical and Physical Geology, translated by the Cavendish Society. 1854.

Subject XIV .- Animal Physiology.

The field presented by Natural History is such an exceedingly wide one, that candidates are advised to confine their studies to the subjects enumerated below, and to master these as thoroughly as possible. And as in the Natural Sciences, the knowledge which is obtainable by mere reading is of very little value, candidates are particularly recommended to study nature for themselves, and to become personally acquainted with the primary facts of Biological Science. Thus in Physiology, the fundamental truths relating to circulation, muscular contraction, and nervous action, may all be readily exemplified by simple experiments upon the common frog; and in Systematic Zoology and Botany, the careful study of the structure of the animal and vegetable forms enumerated under the head of "types" will furnish a better conception of the animal and vegetable worlds than any amount of mer reading. Candidates will therefore be expected to be thoroughly and practically acquainted with the fundamental facts of Physiology, and in Zoology, with all the most important and distinctive characteristics of such of these typical genera as are illustrated by British species.

Candidates should have carefully studied what is stated upon the subjects enumerated below in any good handbook of Physiology.

The general properties of living matter in respect of form, structure, and chemical composition. The meaning of the terms organ, organization, function, development. The difference between high and low organization. The division of physiological labour.

Why the living organism wastes. The difference between vital and putrefactive decomposition. The conditions and ultimate products of vital decomposition. The living body considered as a

machine performing a certain amount of work.

Why food is necessary. The difference between the food of plants and that of animals. The nature of the substances which constitute the food of man. The proximate chemical composition of milk, flour, meat, butter, potatoes, oatmeal, peas, rice, tea, coffee, beer, wine, and spirits; and the distinction of the proximate elements of each into nutritious and innutritious.

Why digestion is necessary, and how that function is performed in the human organism. The structure of the organs by which the following substances are formed, and their uses: saliva, gastric juice, pancreatic juice, bile. How the nutritious products of digestion are separated from the excrementitious residuum. The process of absorption. The means by which absorbed matters are conveyed to all parts of the organism. The structure and composition of human blood. The course and mechanism of the circulation.

Why the elimination of waste products is necessary. Excretion of carbonic acid. The mechanical and physical principles involved in the performance of the respiratory process in man. The excretion of urea and uric acid. The structure of the urinary apparatus, and the mechanical and physical principles involved in its action. The excretion of water as a part of the foregoing processes, and as effected by the skin. The structure and other functions of the skin. The mutual relations of the three great excretory apparatuses.

The conditions and sources of animal heat. The circulatory system of man viewed as a hot-water warming apparatus. The fuel

of the animal economy and its sources.

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Animal mechanics. The human body as a locomotive apparatus. The structure of bones and joints. The structure and properties of muscle.

The structure and functions of nervous matter. The offices of the spinal cord and brain. The nature and mode of action of the sensory organs. Reflex action. Habit, as acquired reflex action. Instinct. Intellectual and emotional operations.

The nature of death, and the difference between general and local

death.

Local death:—1st, as a part of life; e.g. moulting, shedding of skin and teeth. 2nd, as opposed to life; e.g. sloughing and mortification. General death:—1st, as the natural conclusion of life. 2nd, as arising from disease or injury. Usual commencement of death in

the nervous centres, the heart or the lungs.

Reparative processes:—1st. Local, as exhibited in the reproduction of lost parts, healing of wounds, &c. 2nd. General, as shown in the reproduction of the individual by sexual generation. The origin and development of the embryo. The nutrition of the fœtus and of the infant. Hereditary transmission, and the modification of physical and mental characters by education, as the basis of a rational belief in the possibility of human progress.

Subject XV.—Zoology.

 Candidates should have carefully mastered the definitions of the sub-kingdoms, classes, and orders of the Animal Kingdom. They should understand and be able to explain the meaning of the terms employed in such definitions; and they should be able to refer any specimens that may be placed before them to their proper classes.

2. Candidates should be able to give fair answers to questions relating to any or all of the following subjects, and they should be able to identify, refer to their proper orders, and if called upon to do so, describe, the objects enumerated in each section under the head of "types." In almost all cases these "types" are British animals.

By the term Natural History, of such and such an object, is meant such an account of it as is to be found in any standard modern work on Zoology.

i. The structure and mode of multiplication of infusorial animalcules and Foraminifera. The arguments which have been adduced for and against spontaneous generation. The luminosity of the sea, and the nature of the creatures which chiefly cause it. The natural history of the sponge of commerce. Types—Spongia, Vorticella.

ii. The meaning of the terms, zoophyte, coral, coralline. Natural history of the red coral of commerce. Common coral and coral reefs. What such reefs are, where they are formed, and how they grow. Natural history of the common freshwater polype, or hydra, and of the "jelly fishes," or "medusæ" of the sea. A sexual multiplication as exhibited by these creatures. Types—Hydra, Sertularia, Plumularia, Actinia, Corallium, Fungia, Oculina.

iii. Starfishes, sea urchins, and Holothuriæ; their structure and habits, and the metamorphoses which they undergo. Natural and

economical history of Trepang. Types-Uraster, Echinus.

iv. Natural history of the earthworm and the leech. Intestinal worms; their structure, propagation, and mode of entrance into animal bodies. Natural history of the Rotifera. Types—Lumbricus, Hirudo, Distoma, Tænia, Ascaris.

v. Natural history of *Crustacea*. The lobster and crayfish, as exemplifying morphological and teleological laws. The process of ecdysis. Barnacles, acorn shells, and fish lice, as cases of extreme

metamorphosis. The water flea as exemplifying a sexual multiplication. Types—Cancer, Homarus, Astacus, Oniscus, Daphaia, Cyclops, Lepas, Balanus, Argulus.

vi. Natural history of spiders, scorpions, and mites. The "itch insect," centipedes, and millipedes. Types—Tegenaria, Scorpio,

Scolopendra, Julus.

vii. Insects; their mode of breathing as contrasted with that of spiders and crustaceans. The structure of their wings, and the mechanism of flight. The parts of the mouth and their modifications in beetles, bees, butterflies, bugs, and gnats. Structure of the eyes. Nature of stings, saws, and ovipositors. Natural and economic history of the blistering beetle, of the silk moth, of the bee, of the cochineal insect. Natural history of plant lice, of bugs, fleas, and lice. The house fly, blow fly, and gnat; wasps, humble bee, ichneumon flies; "black beetles," crickets, and locusts. The metamorphoses of insects. Types—Metolontha, Blatta, Libellula,

Phryganea, Coccus, Aphis, Bombyx, Apis, Vespa, Musca.

viii. The characteristic peculiarities of the nervous, circulatory, respiratory, and locomotive organs of mollusks in general. Organization of "sea mat" (Flustra). Ascidians and "lamp shells" (Terebratula). Natural history of fresh-water and marine mussels. Nature of mother of pearl. Formation of pearls. Pearl fishery. Natural and economical history of the oyster. Organization of snails and slugs, periwinkles, limpets, whelks. Development of the young of the latter. Nidamental capsules. Cuttlefishes and squids. Paper nautilus. Pearly nautilus. The shipworm and Pholas. Mechanism by which mollusks bore. Types—Flustra, Ascidia, Terebratula, Unio, Mytilus, Ostrea, Pecten, Helix, Patella, Littorina, Buccinum, Chiton, Sepia, Loligo, Argonauta, Nautilus.

ix. Circulatory, respiratory, and reproductive organs of fishes. Their dentition. Natural and economical history of the lamprey, sprat, sardine, herring, pilchard, salmon, trout, eel, cod, haddock, sole, flounder, turbot, mackerel, tunny, sturgeon, skate, ray, dog fish, shark. Electrical fishes. Fishes which are capable of living in air. Pisciculture, or the artificial breeding of fishes. Types—Amphicous, Petromyson, Syngnathus, Cyprinus, Perca, Accipenser, Lepidosteus, Raia, Spinas.

x. Natural history of salamanders, newts, frogs, and toads, Metamorphoses undergone by their young. Types—Salamandra,

Triton, Rana.

xi. Circulatory and respiratory organs of reptiles as distinguished from those of fishes and amphibia. Natural history of snakes, lizards, crocodiles, turtles, and tortoises. Tortoise-shell. Shedding of the skin in reptiles. Types—Coluber, Pelias, Anguis, Lacerla, Crocodilus, Testudo, Chelone.

xii. Organs of locomotion, respiration, voice, circulation, and reproduction of birds. Structure and mode of growth of feathers, Development of the fowl's egg. Artificial hatching. Migration, and instincts of birds. Natural history of domestic birds; of the ostrich, the apteryx, the penguin, and the dodo. Types—Falco, Corous, Columba, Picus, Phasianus, Ardea, Struthio, Anser.

xiii. Organs of respiration, circulation, and reproduction of mammals. Production and nutrition of their young. Placental and implacental mammals. Nature of milk and of the lacteal glands. Peculiarities in the dentition of mammals. Natural and economic history of the domestic mammals; of the ivory and fur yielding mammals; of seals; of whales. The hybernation and migration of mammals. Characters of the orders of mammals. Types—Cercopithecus, Vespertilio, Erinaceus, Lepus, Elephas, Sus,

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Cersus, Bos, Ovis, Felis, Phoca, Phocana, Dasypus, Hulmaturus, Ornithorhunchus.

xiv. The distinctive peculiarities of man. The characters of the principal races of mankind, and their geographical distribution.

Text-books for Physiology.—Carpenter's Animal Physiology, Bohn, 1859;
Dr. Kirke's Manual; Andrew Combe's Physiology applied to Health
and Education. For Zoology.—Dallas's Natural History of Animals;
Orr's Circle of the Sciences; Gosse's Manual of Marine Zoology;
Professor Green's Manual of the Protozoa.

Subject XVI.—Vegetable Physiology and Economic Botany.

In this department the candidate will be expected to answer correctly questions on the following points:—

 The properties of the principal elements entering into the composition of plants. Carbon, oxygen, hydrogen, nitrogen, sulphur, phosphorus, chlorine, iodine, silicon, potassium, sodium, calcium, iron.

2. The composition and properties of the compounds forming the principal part of the structure of plants. Cellulose, starch, dextrine, sugar, fixed oil, gluten, albumen, caseine. The saline compounds forming the ashes of plants.

 The composition and properties of peculiar vegetable products. Volatile oils. Acids. Colouring matters. Alkaloids. Neutral principles.

Chlorophyll.

The origin and growth of the vegetable cell. The tissues of plants.
 Cellular tissue. Intercellular organs. Epidermal tissue. Hairs.

Stomates. Vascular tissue. Woody tissue.

5. The structure and functions of the organs of plants. The root. Spongioles. Absorption and excretion. Nature of vegetable food. The stem. Structure of Exogenous, Endogenous, and Acrogenous stems. The leaf. The forms of leaves. Exhalation. Stipules and bracts. The flower. Calycine, Corollal, Staminal, and Carpellary leaves. Development and nature of pollen. Ovules or seed buds. Vegetable impregnation. Embryo. Seed. Fruits; their nature and forms. The nature of the reproductive organs in flowerless plants.

 The composition and nature of vegetable substances used by man as food. Distinctions between heat-giving and flesh-forming foods. Structure and geographical distribution of plants yielding starch,

sugar, oil, gluten, albumen, and legumin.

Properties of vegetable substances used in the arts and manufactures.
 Vegetable secretions used as dyes.—Indigo, madder, logwood, red sanders wood, quercitron, alkanet, arnotto, gall-nuts, myrobolans.

8. Materials used in the manufacture of textile fabrics.—Cotton, flax,

hemp, coco-nut, jute, New Zealand flax.

 Principal forms of timber trees, and their uses.—Oak, mahogany, teak, pine, &c.

10. Nature of tanning principles and plants yielding tannic acid.—Oak-

bark, valonia, catechu, kino, divi-divi, betel-nut.

11. Gums, oils, and resins used in arts.—Gum arabic, benzoin, rosin, turpentine, camphor, essential oils, coco-nut oil, palm oil, other fixed oils, caoutchouc, gutta pertsha.

12. Substances obtained from the vegetable kingdom and used as medicines.—Opium, quinine, tobacco, jalap, scammony, gentian, aloes, rhubarb, senna, ipecacuanha, sarsaparilla, castor-oil, assafœtida,

myrrh, nux vomica, hemlock.

Text-books for Vegetable Physiology and Economic Botany.—Henfrey's Elementary Course of Botany: Van Voorst. Carpenter's Vegetable Physiology, edited by Dr. Lankester; Bohn. Schleiden's Principles of Scientific Botany: Bohn. A Manual of Structural Botany by M. C. Cooke. Archer's Popular Economic Botany; Regive and Co. Lindley's Medical and Economical Botany; Bradbury and Evans,

Subject XVII.—Systematic Betany.

In this department the candidate will be expected to demonstrate the structure of plants from living specimens.

1. The distinctions between the three great classes of plants, Dicotyledons, Monocotyledons, and Acotyledons. Also of the groups Gymnosperms, Rhizanths, Dictyogens, Acrogens, and Thallogens.

2. The characters of the following orders of British plants should be mastered, and the typical genera recognized, and their structure

understood.

3. Alge. The natural history and uses of sea-weeds. The microscopic structure of diatoms and desmids. Nature of the reproductive organs in this order. Types-Navicula, Desmidium, Conferva, Fucus,

4. Lichens. The natural history and uses of lichens. Structure of their

reproductive organs. Types-Graphis, Collema, Parmelia.

5. Fungi. The natural history of mushrooms, puff-balls, moulds, blights, and toadstools. Their uses in nature. Types—Agaricus, Bovista, Torula, Aspergillus, Morchella, Mucor.

6. Mosses. The nature of their reproductive organs. Types - Bryum,

Sphagnum, Funaria.
7. Ferns. Nature of their rhizomes. Herbaceous and tree ferns. History of Development, and nature of reproductive organs. Types

-Polypodium, Hymenophyllum, Osmunda. 8. Graminaceæ.

The history of grasses and their uses. Nature of the flower in this order. Useful plants of the order. Types-Phleum, Hydrochloa, Panicum, Agrostis, Arundo, Spartina, Avena, Festuca, Hordeum, Triticum, Secale, Nardus, Anatherum.

9. Cyperaceæ. Sedges. Types—Carex, Scirpus.
0. Liliaceæ. The lily tribe, its useful properties. 10. Liliaceæ. Types—Tulipa, Ornithogalum, Muscari.

11. Amaryllidaceæ. The family of the narcissus, snow-drop, snow-flake.

Types—Narcissus, Galanthus.

12. Orchidaceæ. The orchis family. Structure of reproductive organs.

Types—Orchis, Goodyera, Malaxis, Cypripedium.

13. Amentacea. The family of the hazel, chestnut, oak, willow, birch, beech, poplar, and hornbeam. The uses of these plants as timber. &c. Types-Quercus, Corylus, Fagus, Castanea, Betula, Myrica, Salix, Populus.

14. Urticacea. The nettle and hop tribe. Its relations to Moracea, Artocarpacæ, Cannabinaceæ, and Ulmaceæ. The nature of the stings of Urtica, and the bitter principle of the hop. Types—Urtica,

Parietaria, Humulus.

15. Euphorbiace. The spurge family. Foreign forms and their uses. Croton, Cascarilla, Ricinus, Janipha. Apetalous and Polypetalous forms. Types—Euphorbia, Buxus.

The buckwheat and rhubarb tribe. Types—Poly-16. Polygonaceæ. gonum, Rumex.

17. Primulaceæ. The primrose family. Theory of the peculiar position of stamens. Types-Primula, Lysimachia.

18. Labiata. The dead nettle tribe. Peculiar properties of this order. Types-Mentha, Salvia, Thymus, Nepeta, Lamium, Teucrium.

19. Scrophulariaceæ. The scrophularia tribe. Nature of the poisonous properties of the order. Types—Scrophularia, Digitalis, Verbascum, Euphrasia, Veronica, Melampyrum.

20. Boraginaceæ. The borage tribe. Peculiarities of their epidermis. Useful species. Types—Cynoglossum, Borago, Echium, Myosotis Lithospermum.

The tribe of deadly nightshade, henbane, tobacco, and 21. Solanacea. potato. Useful and poisonous species. Types-Solanum, Atropa, Hyoscyamus, Datura. Digitized by 200916 22. Ericaceæ. The heath tribe. Its distinction from Epacridacea.

Types—Erica, Arbutus, Vaccinium, Pyrola, Monotropa.
Compositæ. The composite family. The number of species and 23. Compositæ. The composite family. geographical distribution. Structure of the sub-orders Asteraces. Cichoraceæ, and Cynaraceæ. Types-Tussilago, Aster, Inula, Gnaphalium, Bellis, Artemisia, Achillea, Carlina, Carduus, Cichorium, Leontodon, Lactuca, Crepis.

The Stellate tribe. Its relation to Cinchonaceæ and 24. Stellatæ. Caprifoliaceæ. The properties and useful plants of Cinchonaceæ.

Types-Galium, Rubia.

25. Umbelliferæ. Umbel bearing plants. Character of inflorescence and flowers. Nature of fruit. Structure of cremocarp. Properties of the order. Types-Hydrocotyle, Sanicula, Eryngium, Apium, Sium, Æthusa, Enanthe, Crithmum, Angelica, Pastinaca, Daucus. Torilis, Scandix, Conium, Coriandrum.

26. Cucurbitaces. Melon, cucumber, and gourd family. Useful plants of this order. Type—Bryonia.

27. Rosaceæ. The rose, apple, cherry, and plum tribe. Forms of the fruit. The useful plants of this order. Types—Prunus, Spirca,

Fragaria, Rubus, Geum, Rosa, Cratægus, Pyrus.

28. Leguminosæ. The bean, pes, and clover family. Principal divisions of the family. Structure of the flowers and fruits. plants of the order. Types—Ulex, Trifolium, Vicia, Astragalus, Ornithopus,

29. Cruciferæ. Cabbage, turnip, and mustard tribe. Structure of the flowers and fruits. Useful plants of the order. Properties. Types-Nasturtium, Alliaria, Brassica, Sinapis, Armoracia, Iberis, Isatis.

Crambe, Cakile.

30. Papaveraceæ. The poppy tribe. Properties and mode of collecting opium. Nature of fruit. Types-Papaver, Glaucium, Chelidonium.

31. Ranunculaceæ. The crow-foot tribe. Structure of abnormal genera; Aconitum, Aquilegia, and Delphinium. Nature of poison in order. Types—Ranunculus, Clematis, Helleborus, Pæonia, Anemone.

Text-books for Systematic Botany.—Lindley's Vegetable Kingdom. For British Botany.—Bentham's Handbook of the British Flora, or

Babington's Manual of British Botany.

Subject XVIII.—Mining.

The Art of Mining embraces so wide a field of study that equal practical proficiency in its various branches is not to be expected; but those who wish to gain a general knowledge of it may be recommended to direct their attention to the subjoined heads, viz. :

- 1. Geology and Mineralogy, more particularly those portions of the sciences which bear on the following subjects,—the nature and position in the earth's crust of the useful minerals, the classes of rock with which they are severally associated, the special character of heaves, throws, troubles, and all kinds of dislocation; the particular differences between beds and lodes, and their minerals, and the chief features of irregular repositories.
- 2. The methods of prospecting and searching at surface for ores and other minerals.
- 3. Breaking of ground; the various implements employed, their form, dimensions, and weight; boring for shots; the various modes of firing charges. Heavy charges, how calculated and fired; rules for ensuring safety.

4. Deep boring, under what circumstances applicable, -apparatus for;

description of varieties in use; lining of bore-holes.

Management and supervision; payment of men employed at mines, at surface and underground, varying in principle with the different classes of operation; reasons for tut-work or piece-work, and tribute or bing-tale under different circumstances. Calculations for cost of driving, sinking, transming, &c.

- 6. Physical principles of ventilation; practice of mines where simple natural ventilation is employed; ventilation of large areas and of deep or complicated workings by guiding the natural current; artificial means, and their details, for promoting ventilation. Precautions to be taken under specially dangerous conditions.
- 7. Illumination, of various kinds, their economy; safety lamps in all their best modifications; circumstances under which they should be employed; precautions in their use.
- 8. Mechanical division of the subject. Strength of materials used in mines; human and horse power, principles and construction of machines to which they are applied. Hydraulic machines; construction of the water-wheels, turbines, and pressure engines most suitable to the various operations of mining. Steam engines, for pumping and for winding; arrangement and construction of the varieties most in use. Form and dimensions of boilers. Pumps employed in mines, mode of placing them; construction of the lifts; materials and details of the rods, setoffs, counterbalances, cisterns, and catches. Circumstances under which dams are erected in shafts or levels; mode of building them.

Tubbing of water from shafts; conditions under which it may be done; details of the operation with various materials, wood, brick, stone, cast and wrought iron.

Rails, waggons, and tubs for underground conveyance; employment

of horses and of fixed steam engines for this purpose.

Raising of the mineral through the shafts; various methods in use; chains, ropes (of hemp or wire), their weight, &c. Details of the best application of drums, cages, guides, keeps, and safety doors. Pulleys and shaft frames or poppet heads; protection against over-winding; safety clutches, &c. in case of breakage of rope.

- 9. Opening of ground; quarries and open work; driving of levels, various dimensions and directions according to circumstances; sinking of shafts, inclined or perpendicular; advantages of either kind under certain conditions; means of securing levels and shafts by timber or by walling; details of the various methods. Driving or sinking in heavy or running ground.
- 10. Working excavations; plan of laying them out, and means of security to be adopted whilst they are kept open. This will include the stoping of metalliferous veins, and the various modifications of post and stall, long-work, &c., which are applied to stratified deposits.
- 11. Travelling in shafts; prevention of accidents by proper fitting and dividing; mode of placing ladders and sollars; lifting machine for men, construction and advantages of.
- 12. Dressing of minerals. Arrangement of dressing floors. Construction of crusher and stamps; washing of coal; jigging, concentration, and separation of metallic minerals.

The student may be advised among other sources of information to consult the following works:—

De la Beche's Report on Cornwall and Devon. Greenwell's Treatise on Mine-Engineering. Dunn on the Winning and Working of Collieries. Hedley on Colliery Working and Ventilation. Evidence hefore Committees of the Houses of Lords and Commons on Accidents in Mines. Reports of H.M. Inspectors of Coal Mines. Transactions of the Northern Institute of Mining Engineers.

Subject MIM.—Metallurgy. I. Introduction.

On certain physical properties of metals. Action of heat, specific gravity, crystallization, fracture, malleability, ductility, tenacity, conductivity of heat and electricity, opacity, lustre, colour. General considerations on metallurgical processes. Modes of occurrence of metals in nature, ores, reduction, smelting, roasting, liquation, slags.

II. Puel.

General remarks, calorific power, calorific intensity, classification of fuels, wood, peat, lignite, coal, charcoal, coke, gaseous fuel and gas furnaces, charcoal burning, coke burning, typical varieties of coke ovens, comparison of fuels with respect to calorific power. This important branch of the subject is treated with much detail.

III. Refractory materials employed in the construction of furnaces, crucibles, &c.

Fire-clays British and foreign, crucibles of various kinds, plumbago and its application to crucibles, manufacture of crucibles, fire-bricks, silica and its applications, Dinas fire-bricks, sand and sandstones.

IV. Special Metallurey.

Copper.—Compounds of special importance in the metallurgy of this metal fully described, such as the disulphide, oxides, &c., ores of copper, copper-smelting in reverberatory and blast furnaces, reactions occurring in the process, kernel-roasting, 'wet' methods, of extracting copper from its ores, assaying of copper ores by 'dry' and 'wet' methods,

ship sheathing.

Zinc.—In describing the metallurgy of zinc and the following metals, the same plan will be followed as in describing the metallurgy of copper, that is to say, the compounds of special metallurgical importance will be first considered in detail, as well as the reactions upon which the various processes of smelting essentially depend, and the construction of the furnaces will be fully explained. Ores of zinc, English, Belgian, Silesian, and Carinthian methods of extraction, assaying of zinc ores brass, its history, properties and manufacture.

Lead.—Ores of lead, lead smelting in the 'ore-hearth,' low blast and reverberatory furnaces, lead-fume and various methods adopted for its

condensation, assaying of lead ores.

Silver.—Ores of silver; smelting of silver ores with lead; cupellation; desilverization of lead by Pattinson's process, also by that of Parkes; treatment of argentiferous copper by liquation; extraction of silver; amalgamation, the old Freiberg method and the Mexican; Ziervogel and Augustin's 'wet' methods; treatment of argentiferous copper-regulus; alloys of silver and copper; standard silver; assaying of silver ores and alloys.

Gold.—Modes of occurrence of gold in nature; extraction by amalgamation and by smelting with lead; chlorine-water as a solvent for the extraction of gold from certain ores; separation of gold from silver or parting by nitric and by sulphuric acids; alloys of gold with the preceding metals; standard alloys; assaying of auriferous ores and

llovs.

Mercury.—Orez of mercury; extraction in the Almaden, Idrian, and Hähner furnaces; in retorts in admixture with reducing agents; assaying

of the ores of mercury.

Antimony.—Ores of antimony; liquation of the native sulphide and its subsequent reduction by iron or other agents; alloys of antimony, type metal, &c.; assaying of the ores of antimony.

Bismuth.—Mode of occurrence in nature; its extraction from ores

containing it by liquation; alloys of bismuth.

Nickel.—Ores of nickel; modes of extraction, generally by a combination of 'dry' and 'wet' processes; alloys of nickel, especially those known as German silver; assaying of nickeliferous ores and alloys.

Cobalt .- Ores of cobalt; smelting and preparation of zaffre and cobalt colours, smalts, &c.; separation of nickel; assaying of cobalt ores.

Arsenic .- Mode of occurrence in nature; arsenious acid or 'glass' of arsenic, generally obtained as a secondary product in the treatment of certain other ores, such as those of nickel, cobalt, &c.; modes of condensation of arsenical fumes; preparations of arsenical 'glass,'

Tin.—Ores of tin; smelting in reverberatory and blast furnaces; tin. refining; varieties of tin in commerce; alloys of tin, with the preceding

metals, bronze, gun-metal, bell-metal, &c.; assaying of tin-ores.

Iron.—Malleable iron; steel; pig-iron; ores of iron, direct extraction of iron in the malleable state from the ore; smelting of iron in the modern-blast furnace; construction of blast-furnaces and blowing machines; economic application of the waste gases; conversion of pig into bar iron in open hearths and in the reverberatory furnace; manufacture of steel by various methods. This department of the subject will be treated at considerable length.

Various Metals.—Platinum and its associated metals; cadmium;

sodium; aluminium; tungsten; titanium; manganese.

Subject XX .- Navigation.

1. Elementary Principles.—Problems relating to latitude, longitude; differences of latitude, and differences of longitude.

Relation between an arc of a parallel of latitude and an arc of the equator. Principles of plane sailing and middle latitude sailing. Principles of Mercator's sailing. Mercator's chart. Principles of

great circle sailing. The compass and its corrections.

(1.) Variation. (2.) Deviation. (3.) Local attraction. (4.) General theory of deviation (Towson's Practical Information, first 50 articles). Correction of courses for variation, deviation, and leeway. The log. Correction of estimated distances run for errors in the log line and glass. Plane sailing. Traverse sailing. Middle latitude sailing. Mercator's sailing, with examples.

To find difference of longitude made on a traverse. Sea journal. A day's work. Practice of great circle sailing. Circular arc sailing. Tides. Winds. Cyclones. To find bearing of a circular storm; veering of wind; heaving to; and sailing from centre of gale.

Construction of tables of meridional parts.

Description and use of sextant, with the theory, adjustments, and errors.

Note.—Candidates for certificates as teachers of Navigation will be required to possess a competent knowledge of the whole of the above syllabus, and to have obtained a certificate in elementary mathematics and passed in higher mathematics as far as spherical trigonometry inclusive.

For students.-To "pass," as far as principles of plane sailing. The

compass and correction of courses.

For honourable mention.—As far as Mercator's sailing, with examples. For third, second, and first class Queen's prizes, a proportionate knowledge of the remainder.

Subject XXI.—Nautical Astronomy.

Definitions. Time, apparent, mean, sidereal, &c. Equation of time. To express interval of mean or sidereal time in parts of sidereal or mean time respectively. To convert arc into time, and conversely. To find Greenwich date. To take out right ascension of sun for a given mean Greenwich date.

Correction of altitudes. Dip. Parallax. Refraction. Augmentation of moon's semi-diameter. Reduction of altitude of a heavenly body observed at one place to what it would have been if observed at another. The chronometer and its use, error, and rate.

Latitude by meridian altitude of sun, and fixed star.

Latitude by meridian altitude of moon. To find Greenwich mean time of moon's meridian passage. To find semidiameter and horizontal parallax of moon for a given Greenwich date. To take out from Nautical Almanac moon's declination, &c.

To find local and Greenwich mean time of passage of a star over a given meridian on a given day. Latitude by altitude of sun, star, or moon below the pole and by pole star. Latitude by altitude of sun or other heavenly body near the meridian. Calculations of hour angles. Meridian distances. Right ascensions. Computations of time. Error and rate of chronometer. Computation of mean or apparent time at any place from observed altitude of a heavenly body. Longitude by chronometer. Error in hour angle from error in observed altitude. Variation of compass. Azimuth, altitudes, amplitudes, determination of true bearings. True azimuth from altitude of heavenly body and without observed altitude. True bearing of a point of land, &c., by observed angular distance from the sun. Variation of compass from observed amplitude of sun.

Deviation of compass, from Art. 50 to end of Towson's Practical Information. Sumner's method of finding longitude and latitude.

Method of double altitudes, Ivory's and direct. Error of chronometer by equal altitudes of sun and fixed star. To compute apparent altitude of a heavenly body when its true altitude is given.

Methods of clearing a lunar distance from the effects of parallax and refraction. To find Greenwich date corresponding to a given true lunar distance, &c. To find the altitudes when a lunar distance is taken from altitudes before and after taking the distance. To find the longitude by a lunar. Rate of chronometer by a lunar.

OBS.—In all the above problems the demonstration of the rules as

well as accurate practical working is required.

Note.—Candidates for certificates as teachers will be required to possess a competent knowledge of all the above syllabus, and to have obtained a certificate in the elementary mathematics, and passed in higher mathematics as far as spherical trigonometry inclusive.

For students.—To "pass," a knowledge of the elementary principles,

and finding latitude by meridian altitudes of a heavenly body.

For "honourable mention," the above, with variation of compass from altitudes and azimuths, and rate of chronometer, and longitude by chronometer, is required.

For third, second, and first class Queen's prizes, a more or less accurate

knowledge of the remainder.

Subject XXII.—Steam.

General Properties of Steam.—General effects of heat and cold, with practical applications of the principle. Law of expansion by heat not universal. Beneficial result of this anomaly. To ascertain the temperature of any substance. Pyrometer. Thermometer—Description—Graduation. Comparison of thermometers when differently graduated. Laws of cooling. Conduction. Conducting powers of bodies. Convection. Explanation of some natural phenomena by this law. Radiation. Radiating power of bodies. On what it depends. Land and sea breezes. Capacity for heat. Unit of caloric. Latent

heat. Under what circumstances heat becomes latent. Heat sole agent in melting and vaporising bodies. Calorimeter. Sources of heat. Combustion. Temperature necessary for it. Boiling point. Temperature of elastic fluids. Vapour. Formation of dew. Distinction between vapour and steam. Boiling points of fresh and salt water. Distillation. High-pressure steam. Measure of steam by atmospheres. Steam when in contact and when not in contact with boiling water. Relation between pressure, density, and temperature of steam. Specific gravity of steam. Common, superheated and surcharged steam. Priming. Analysis of sea water.

2. Steam Engine. - General principles. Different kinds. Engines in use before Watt. Newcomen's engine. Its defects. Discoveries of Watt. Blowing through. Defects in atmospheric engines. Single acting and double acting engines. Expansion valve. Cornish-High-pressure or non-condensing engine. Marine steam engine. Different descriptions. Side-lever marine engine. Blow-valve. Stuffing boxes. Piston of steam cylinder. Working parts. Working of the slides, strap, gib, and cutter. Escape valve of cylinder. Parallel motion. Hall's condensers. Test cocks. Grease cocks. Grease cups of slides. Annular air-pump bucket. Annular delivery valve. Various kinds of slides. Cushioning. Lead. Lap, its effects. The eccentric. Throw and stops of ditto. To find the travel of the slide. Back-lash. Double eccentric. Throttle valve. Expansion valve and various kinds. Barometer or condenser Method of estimating pressure by it. Errors in this method, and correction of the same. Lubricators, &c. Number of engines in a steamer. Expansion cams and gear. Feed pumps. Bilge pumps. Modes of propulsion. Paddle wheels. Pitch, Reefing. Disconnexion and immersion of wheels. Brakes.—Modes of fitting. The screw propeller. Length, angle, pitch, slip, area of screw blade. Disconnecting and raising screw. Governors, Direct acting engines. Gorgon—Fairbairn's double cylinder, oscillating, trunk engines, &c. Engines for screw propellers. Direct acting, with and without multiplying gear. Oscillating horizontal and trunk engines. Double acting air-pump.

3. Boilers.—Description. Gear connected with them. Tubular boiler. Number of boilers. Steam chest. Safety valve. Waste. Steam funnel and drip pipe to steam gauge. Wash or dash plates. The funnel dampers. Reverse valve. Communication or stop valve. Blow-out cocks. Circulating pipes. Brine pumps. Brine valves.

Refrigerators.

4. Calculations.—Methods of measuring efficiency of steam engines. Duty of an engine. Horse power. Mercantile or nominal horse power. Horse power from the evaporation in the boiler. De Pambour's theory. Velocity of maximum useful effect. To find evaporation of a condensing engine of given dimensions and horse power, the piston moving with a given velocity with and without expansion. To find the pressure in cylinder, knowing the effective evaporation. To find the diameter of a cylinder to work at a certain speed, knowing the evaporation. To find the evaporation in the boiler, knowing the diameter and velocity of piston and pressure of steam in the cylinder with and without expansion. Same for locamotive, Watt's engines, &c.

The screw—to find its area. Angle of the helix or thread of the screw propeller—to find the pitch. The power exerted by a screw. How far slip depends on form and dimensions of the screw. Motion of paddle-wheels, &c. Consumption of fuel. Measure of locomotive performance of marine steam engines. To find the angle the

crank has moved through when the piston is at a given distance from the top of the stroke. Amount of work developed by crank in a half-revolution-length of radius-bar in side lever engine. Work done in the up and down stroke of the air pump. The best temperature for the condenser of a steam engine. Qualities of fuel, &c.

5. Practical working.—Getting up steam. Mode of starting. Working engines at moorings. Priming—causes and remedies. Banking up and putting back fires, &c. Duties to machinery when under steam, boiler, fires, &c. Injection pipes. Kingston's valves. Leaks in engines. Bearings of engines. Expansive working. Management of fuel. Damages and repairs to boiler, &c., after accidents. Duties to engine, &c., on arriving in harbour.

 Indicator.—The ends it fulfils. Description. Atmospheric line. Method of taking a diagram. The general configuration of diagram to be expected under various circumstances. The slide-diagram. Examination of Indicator-diagram when steam is throttled; when expansive gear alone used, and in other cases. To ascertain the horsepower of an engine by means of the indicator. To find quantity of water evaporated. Friction of steam engine without load. Diagram when there is no condensation. Diagram showing the relative motions of slide and piston at every point of the stroke.

Dynamometer. To find horse-power of engine by means of it.

The text books specially recommended are—The Marine Steam Engine, by Professor Main and Mr. Brown, R.N., Longmans and Co.; Main and Brown's Indicator and Dynamometer; De Pambour's Theory of the Steam Engine.

Note.—No certificate as a teacher of steam will be given unless the candidate has obtained a certificate in elementary mathematics and theoretical mechanics; and no first grade certificate, unless he has taken a certificate in higher mathematics.

Subject XXIII .- Physical Geography.

The knowledge included in this subject embraces:-

a. A general acquaintance with astronomy, so far as it relates to

terrestrial phenomena.

b. Distribution of the land and water; forms of the great continents; the general structure of land with regard to mountains, table lands, plains, deserts, islands, &c.

c. The ocean; its physical and chemical characters, temperature, depth, waves, tides, tidal bore, progress of the tide wave, ocean

currents, and soundings.

d. Inland waters, including the phenomena of springs, rivers, lakes, and influence of the distribution of inland waters upon com-

e. Winds, including land and sea breezes, trade winds, variable winds, law of storms, cyclones, &c.

f. Climate: physical causes which determine climate, isothermal lines, and temperature tables.

g. Distribution of plants and animals, especially as their produce is turned into articles of commerce; and classification of the races of man.

h. Information on the physical geography of the British and Colonial Empire of Great Britain, with especial reference to exports and imports.

SCIENCE FORM, No. 232.

CIRCULAR MEMORANDUM TO SCIENCE SCHOOLS AND CLASSES.

By the advice of the Examiners in Science, the Lords of the Committee of Council on Education have sanctioned the following rules for the examination of Science Schools and Classes in May:—

- 1. That there shall be two examination papers in each subject; one of which (the first) will be an easy paper, the other (the second) more difficult.
- 2. That the candidate shall be allowed to select questions out of either the first or the second paper; but not out of both.
- 3. That the candidate shall be restricted to a certain number of questions in each paper—the number which he may fairly answer in the time allowed—and that the paper shall consist of about half as many more questions. Thus, if eight questions in a paper can fairly be answered in the three hours, the paper will consist of about twelve questions, and the candidate will be allowed to attempt any eight of those, but no more.

4. That the 5th and 4th class shall be obtained from the first paper only, and the 1st and 2nd class from the second paper only; whilst the 3rd class may be obtained from either the first or the second paper.

Thus, for instance, if the candidate is restricted to eight questions in the first paper and to ten in the second paper in a subject, then the number of marks attached to some eight and some ten of those questions respectively will be 100, and 40, 60, and 80* marks in the first paper will give a 5th, 4th, or 3rd class respectively, while 40, 60, and 80 marks in the second or difficult paper will give a 3rd, 2nd, or 1st class. The 3rd class will thus be obtained either by very good answering in the easy paper or by fair answering in the difficult.

5. Teachers are recommended to explain the system fully to their pupils before they come up to examination, and, if possible, from their knowledge of the students' attainments, to advise them which paper to attempt.

^{*} These per-centages are only given as examples. The scale may vary from time to time.

LIST of SCIENCE SCHOOLS and CLASSES, showing the NUMBER of STUDENTS under INSTRUCTION in 1865-66, and NUMBER of Medals and Prizes obtained.

Number of Number of Of Prizes.	1864, 1865, 1864, 1865,		-: -:	:		63	:	.:. ::	::	16 19 {1 G. 1 }	:	:	16 14 1B.	:	12 10	31 97 { 26.9. 28.9.	9 13 1G	
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Teacher.	`		Ratoliffe, Wm Gunn, W.	Slater, James K } { Jones, Thomas - }	Jarmain, George	Marriott, J. T. Butterworth, Thos.	Gibson, George H	Butterworth, Thos.	Beale, J. H. Wilson, Alexander -	Woodward, C. J.	Gunn, William - Downing, Sampson		Spriggs, C.	Collins, J.	Collins, J.	Coomber, Thomas Leipner, A. Plant, E. C. Welsh, J.	Shore, T. W.	Chickup, W.
Secretary.		ENGLAND.	Ratcliffe, Wm	Railton, G. W	Jones, Rev. Lewis Jarmain, George	Footner, Richd. Lawton, Thomas	Dalby, John .	Howorth, D. F. Newbigging, T.	Cadbury, James Cadbury, James	Smith, Edwin .	Hand, Thomas -	Marsden, Peter C.	Lowe, Rev. J	Vickers, James-	Lowe, Rev. J.	Wilkson, John -	Briggs, Benjamin W.	•
Chairman.			Ingram, J	Consterdine, Rev.	Dyson, Edward -	Bracker, Henry F	Smith, H. E.	Mason, Hugh -	Harlock, John	Martineau, T.	Thompson, James - Collins, C. M. E.	Cannon, W. W.	Hick, John	Winterburn, Geo	Hick, John	The Rev. Canon Moseley.	Parker, A. Townley	
Where held.			Mechanics' Institution	Day School Room -	King James' Grammar	Mechanics' Institution - Chancery Lane Educational	ement So-		Academy -	Midland Institute -	т. п	•	Mechanics' Institution .	lent Methodists'	Holy Trinity Working Men's	de School	Church of England Literary Institute.	
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Gunn, William	Odnn, W.	Clement, Leonard	{Shore, T. W} {Healey, T}	Spriggs, C	Robotham, W S Bush, James - S	Notcutt, W. L.	Judd, William	Gunn, William Davidson, Ellis A.	Spriggs, Christo-	(Salter, E	Wilcox. E.	D'Urban, W.S.M.	Shaw, Henry C.	Jeffery, Walter .	Solves, Thomas - Sausbridge, W.	Weatherill, Robert -	{ Jarmain, George - } { Parke, G. H.	Shore, Thomas, W.	Wheeler, G. H.	Scaping, Zebedee	Richardson, Joseph,	Hartley, Joseph	Fallows, J. F.	Packer, M. W.
Greenwood, David	Sutherland, J	Massey, J.	Sutherland, J	Pomfret, Joseph	Price, Peter -	Moore, H. J.	Jenkins, Henry	-	Blackburn, James	Kynder, J. B.	Hooper, C. H	Tucker, J. T.	Hodges, S.	Fowler, Rev. H.	Jordan, Charles H.	Webster, Thomas	Gibb, George	Binns, John -	Smith, Rev.C.W.		Birch, William,	Turner, William	Lawton, Thomas	Harvey, J. K
Maclure, Bev. E. C. Greenwood, David	Shuttleworth, Sir	Massey, L.	Shuttleworth, Sir	Hildysrd, C. F.	Watkins, W. B.	Downing, James -	Holloway, J. E.	Dewhurst, Robert - Ramsbotham, James	Christy, Richard .	Woolnough, C.	Peters, Rev. Thomas	Head, R. T.		Waghbourn, Bu-	cnanan. Purviss, P.	Chaloner, Thomas -	Ackroyd, Edward -	Thompson, Robt	Ramsbotham, Rev. T.	Reimers, Francis T.	Aspden, Richard -	Gaskill, J.	Hibbert, Edward .	Brinton, John -
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Schools established in 1865.

List of Science Schools and Classes, &c.—continued.

Town.	Where held.	Chairman.	Secretary.	Teacher.	Number of Individuals under	er of duals ler	.96.8		Number of Prizes.	1 3 3 S	Number of Medals.	er of
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Kinver	National Schoolroom .	Wharton, George -	Bolton, Thomas.	Packer, M. W.	2	33	:	73	-	•	:	:
Leeds -	Mechanics Institution St. Martin's School and	Oxley, Henry . Vaughan, Rev. D. J.	Blaker, Barnett Jones, H. S.	Ward, George Atkins, Edward	\$:	83	:3	-:	ᆵ:	20	::	::
Liverpool Lianelly	Ashwell Street School. Free Library - Copper Works School	Samuelson, James - Nevill, C. W.	Gregson, S. Leigh Davies, John	Birkenhead, E. H. Jones, John	₩.:	82	::8	• :	ຂ:	. st	8 B.	16.
London:— Bethnal Green - Bethnal Green -	Birkbeck Schools St. Matthew's School	Tidcombe, Bev	Runtz, George - Halliday, J.	Pike, Robert W. Simpson, B.	88	95 82	11			60	::	· ::
Camden Town - Gt. OrmondStreet	Camden Hall Working Men's Institution	Litchfield, R. B.	Waterman, O	Snelus, George J.		% :	88	:	:	6	::	•::
Homerton - Islington	Parochial School . Lower Public School .	Godding, Rev. J Fleming, Rev. W	Goslin, John - Ross, John -	Crowe, William Howard, John	•:8	221	42		: <u>~</u>	: 2	1 Ġ.	1 G. 1
Kingsland -	North London School of Science.	Aveling, Thos	Hoskins, W. H.	Trte, Ralph Bithell, Bichard	2	2	:	10	••	10	:	18.
Polytechnic -	Royal Polytechnic Institution Mackenzie, Rev. C	Mackenzie, Rev. C	Cousens, James	Snelus, G. J.	2	34	:	- R	:		:	:
City of London Wells Street.	Sailors' Home -	Maude, Francis,	Webb, W. H.	Newton, J.	:83	:82	:2	::	::	::	::	ų:
Loughborough	The Institute	Herrick, W. P.	Marshall, J. M	Scott, John	ន	81	:	20	10	10	:	:
Macelesfield	Mechanics' Institution -	Arthy, Bev. W. B. B.	Brooker, John -	Wire, Alfred P. & }	8	8	:	-	- 9	:	1 G.	:
Manchester -	Modern Free School	Callendar, W. Ro- main, Jun.	Brooker, John - Huntington, Rev. G.	Jackson, John Collins, John	88	88	:10	» :	81 kg	:4	1.8:	::
	Mechanics' Institution	Bowker, W. (the Mayor.)	Jarrett, Albert -	Collins, J.	182	88	91	.	10	<u></u>	S. 4 B.	38. 4B.38.,9B.
"Middleton".	Corporation Street Roby Educational Institute Mechanics Institution National School	Turner, Wright Ellis, R. P. Gilkee, Edgar Dumford, Rev. R.	Noar, William - Hilis, Robt. P Taylor, Wm Ward, Rev. C. B.	Express, Control of Schooled, J. Stock, H. F. K Wheeler George H.	ಷ್	Sam Z	-m :2	::न:	83 :es :	₫:4:	::::	18,1B.
Nelson-in-Marsden Lomeshays Mills	Lomeshaye Mills .	Ecroyd, Wm	Waddington, J.	Waddington, J. Clement, Leonard .	23		•		- :	2	:	:

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Bush, James	Hartley, J. Weatherill. Robert.	{Sissling, W }	Mellor, James	Rockert, L. C.	Butterworth, J.	Pullen, Moses - Hartley, Joseph	Evers, H. Hearder, J. N. Holmes, T.	Merrifield, John Bobotham, W.	{Birkenhead, E. H.}	Mapp, George .	Hudson, F.	Parke, G. H.			Packer, M. W.	Vick, William	{ Viocars, Thos} {Barter, W. A}
Richards, Thos.,	Evans, George Movle, Rev. V.H.	Thurlow, Richard	Walters, Bev. W.	Bailey, Thomas -	Taylor, H.	Skinner, J. W. Harrop, J.	Cawse, J. H. M	Cumming, W. B. Spickett, E. C	Dunn, James .	Milward, V. Grylls, W. M.	Noar, Wm.	Pickles, J. Hulbert, P. W.	Chapman, J. Newton, Edwin B. Hawke, E.H. jun. Alcock, Rev. H.J. Boyns, Richard	Robinson, S.	Welch, J. J.	Boucher, Edwin Foster, Wm.	Weeks, Caleb -
Lewis, Thos. T.	Taylor, Joshua Pennyman, J. S.	Morse, Francis	Bamford, John	Platt, J		Gardner, W Ashworth, Joseph -	Norrington, Chas (the Mayor).	Hill, R. Perkins, Wm.	Wilson, Thomas -	Fessey, Rev. Geo. F. Manley, Rev. W. L.	Turner, Wright .	Dean, Dr. Hulbert, Rev. C. A.	Cree, Rev. J. A. Marsland, John Rogers, S. Mocatta, Rev. W. A. Hadow, G.	Barr, W. R. (the		White, Rev. W. F	Vivian, Edward .
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The Athenaum and	Mechanics Institution Church Institution	Mechanics' Institution	Parish Church School	Science and Art School	Analytical Institution	Free School Mechanics' Institution	St. Andrew's Working Men's School.	Navigation School School School Room, Taff Street	Institution for Diffusion of Useful Knowledge.	National Schools The Institution	Working Men's College	Mechanics' Institution Meeke and Walker's Educa-	Mechanics' Institution Mechanics' Institution Girls' Schoolroom St. Thomas's National School The Institute	Mechanics' Institution	Grammar School	The Institution -	British School
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Newport -	Newton Heath North Ormesby	Nottingham -	Oldham -	•		Painswick -	Plymouth -	Plymouth -	Preston .	Redditch .	Salford .	Slaithwaite - "	Slough Staleybridge St. Day St. Helen's St. Just	Stockport .	Stourbridge -	Stronehouse - Strond -	Torquay .

* Schools established in 1865.

List of Science Schools and Classes, &c.—continued.

Number of Medals.	1865.	: 	::::	· :	ei .	1 38	· ; ·:	- 	•	:	•	:	:	: :			•		:
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India '	Instru 1864–5.	3	81:88	\$	8	:	31 3:			Z	ES	22	.	130	22	Ħ	3	•	
Teacher		Davis, Uriah J.	Sutcliffe, Henry Birkenhead, E. H.	Burgess, Rev. S.	Jones, Thomas	Snelus, G. J.	Stockton, W.	Corawiey, S 51	(Braiser, J. S)	Maver, D.	Jones, J. B.	Macomish, Margaret	Kennedy, John	Mayer, J.	Machattie, Alex. T.	Stevenson, James }	Bolam, James .	Black Robert	
Secretary.		Betts, Rev. J	Ward, Henry Peace, M. W.	Meadley, J.	Keeble, W. D	Wilson, James -	Butcher, M	SCOTLAND.		Sinclair, J.	Kellas, Jas. F	Hourston, S. '-	Cumming, A. W.	Cunliffe, Bich. S.	-	Crawford, Robt.	Thomson, Rev.J.	IRELAND.	ALY DOLL DOLL OF THE
Chairman.			Tisson, W	Mumford, A. L.	Anderson, James -	Brown, Rev. H.	Palmer, Rev. H. V.			- Matthews, James -		Sturrock, George -	Sturrock, John '	~	The Lord Provost {	Aitken, Rev. James	Lindsay, Wm.	Down Row D. W.	THOM THE TOOK THE ALL
Where held.		Schoolroom	Christian Institution Mechanics' Institution Mowbray House School	Science and Art Institution	Mechanics Institution,	National School	Navigation School Popular Institution -	-		- Mechanics' Institution -	Navigation School .	Girls' School	High School -	Secular School	Athenseum -	optool	Navigation School .		_
Town.		Upton, St. Leonard's	Walsall West Bromwich Wigan Wolverhampton	Wolverton .	Woolwich -	•	Yarmouth, Great -			Aberdeen	• .	Cornock	Dundee	Glasgow	• • •	Kilmarnock	Leith	ellemens.	and mount

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McNeill, James	Barklie, Robert Smeeth, Rowland	Doran, George	Stevenson, J. McN.	Dowling, John	Woodhouse, John Mayne, Arthur J.	Graham, M. M 5	Speers, Adam -	Stevenson, J. McN. }	Hay, Wm.	Harbison, M. Greer, W. H.	{ Beatty, J }	MacMillan, Wm.	Begley, Geo. B.	Mayne, A. J.	Freehill, M	Dowling, James	
Nesbitt, R.	٠ ; ٠	Nesbitt, R.	Nesbitt, B.		Woodhouse, John	Price, Newton -	Shepherd, Wm.	•	Eccles, Wm.	Osborne, A. T Osborne, A. T	O'Neill, Richard	Appelbe, Bev.	Orr, John	Hackett, Bev. J. W. Mayne, A. J.	Connell, E. A Bradley, J. A	Cewet, James .	
Lyth, John	Lyth, John Patten James LL.D.		Birnie, T. M Rogers, Rev. John -	Manning, Joseph -		Neyille, John	Patterson, R.	McKay, Rev. C. E		Moore, Rev. H. Pooler, Rev. J. G.	Durdin, J. G.	Sherrington, T. A	Filson, Alex. B	West, The Very Rev.	Lightburne, H. Gunning, Robert	Hoare, The Very Rev. E. N., Dean of Wa- terford,	
Royal Academical Institute Rosemary Street National School		Navigation School	Model School - Smyth's National School -		Christian Schools	ree morey .	Sullivan's Nat. Model School Patterson, B.	ational School	Model School	Model School	Endowed School	Thomas Street National	National School		The Model School Church Street National	Model School -	
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* Schools established in 1865.

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.XI	Magnetism and Electricity.	<u>:</u>	:	:	:	:	·H	:	-	:	:	• •	. 	:	:
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.VI	Elementary Ma- thematics.	:	:	:	- :	::	•:	::	::	::	· :	; ** :	:	:	-
III.	Building Con- struction & Naval Architecture.	:	:	:	:	:	•	÷:	:	•	•:	• :	:	:	:
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TABLE Showing CERTIFICATES held by SCIENCE TEACHERS.

Revised by the Examination, of November 1865.

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Table showing Certificates held by Science Teachers-continued.

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Kellett, Joseph	Prospect House Academy, Birstal, near	1887	<u>:</u>	: \$:	:		<u>.</u>	:	<u>:</u> :	<u>:</u>	<u>:</u> ,	<u>:</u>	:			:	\div	<u>•:</u>	<u>:</u>	<u>:</u>	:	<u>:</u>	
Kelly, James J. Kennedy, John	Gladsmuir Parish School, Bast Lothian School of Art, Dundee	<u>.</u>	:-	::	::	::	· · ·	: ;:		≈ : ∞ :	∞ :	::	::	::	$\frac{\cdot \cdot}{\cdot \cdot}$::	::	::	::	::	-::	<u>::</u>	::	
Kenyon, Benjamin D.	11. Darlington Street, Cheetham B. Manchester.	HIII	:	:	:	:	:	<u>:</u>		<u>:</u> :	•	:	<u>:</u>	:		:	:	<u>:</u>	<u>:</u>	<u>:</u>	<u>:</u>	:	<u>:</u>	
Kerby, Isaac King, Charles King, Thomas Kitchen, William .	Training College, Westminster County School, Leicester Wesleyan College, Westminster	••••	::::	::::	::::	::::	::::	•••••		e : : :	:000	::00:	::::	::::	::::	::::	::::	::::	::::	::::	::::	::::	::::	
Latchford, George Lee, John . Lee, Robert Leipner, F. J. Adolph Lealie, George J.	St Mark's College, Chelsea - All Saints' School, Preston - 22, Upper Park Street, Olifon 8, Heriot Place, Edinburgh		:::::		:::::	α₁:::∞		- ca	****	<u>::::::</u>	:::::	::• ::	:::::	:::::	:::01	:::-::	:::09:	::::	:::::	on ::::	69 : : : :	-::::	:::::	
Lewis, Richard A. Lightbown, James H. Lines, John Lloyd, William Longhottom, Josiah	Engineers' Office, Crewe Highfield View, Crossland, Salford St. Mark's College, Chelsea St. Mark's College, Chelsea Wesleyan College, Westminster	• • • • • •	:;:::;	:;:;;	::::	:::::		⁶⁴ ; ; ; ;	<u> </u>	:::::	:	:09 : : :	:::::	:::::	:::::	:::::	:::::	:::::	:::::	:::::	:::::	. :::::		
Lumpe, Francis Lyons, Michael McCallum, James McCarthy, Denis Macdonald, William M.	23, Redoliffe Road, London Grammar School, Dundalk Rallway Workshops, Kilmarnock- Cookrane and Co., Ormeeby Iron Works, Middlesboro-on-Rees.	r, , , ag	::-::		:::::	:::::::::::::::::::::::::::::::::::::::		4::::		:01 : : :		F::::	:::::	:::::	:::::	:::::	;64 ; ; ;	:es : : :	<u> </u>	::: - :	:::-:	:::::	:::-:	
McFarlane, Archibald McGowan, Francis M. Machattie, Alex. T McIvor, Alexander - Mackrell, Issac -	East Hardwick, Pontefract Model School, Newtownards 1, Stanley Street, Glasgow Wesleyan School, Dartford		:::::	:::::	;::::	:::::	:::::	:::::		:03 :400	:: 7:09	** : r : :	:::::	:::::	:::::	:::::	· · · · · ·	• : : : :	<u> </u>	:::::	:::::		<u> </u>	
Macmillan, William - Macmillan, Robert - Macmillan, Edw. H McNeill, James - Macomish, Margaret	Thomas Street School, Portadown District Model School, Sligo National School, Campden St, Chandos Street, Belfast Corsock, near Dalbeattie		:::::	:::::	::::;	: es : es :	:::::	;ea : : :	:01 : : :	:07 :::	::01::	:::::	:::::	:::::	::::=	:00 : : :	ea : : : :	<u>:::::</u>	:::::	:::::	:::::			
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		Name.	Mapp, George Marriott, John T. Marshall, John B. Martin, William Mayor, James Mayor, John Mayer, John Mayer, John Mayer, John Mayer, John Millier, James Mertick, Edward Mertick, Edward Mertich, James Mertich, Joseph W. Millier, Joseph W. Millier, Joseph W. Millis, Joseph J. Morris, Mark Morris, Mark Morris, Mark Millis, Joseph J. Mill

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Nelson, B. E. Newton, John	Navigation School, Shadwall Navigation School, Well Street Camborne House, Ventnor-	·; ;	-:::	::::	HH :	:: :	:::	:: :	:: 67	-:	::::		::::	:::	::::	:: :		-:::					
ism L.	Arsenal School, Woolwich 15, Salishury Street, Lisson Grove, London 8, Oxford Street, Ohelteanan Fortwilliam, Upton, County Cork		::::	::;;	·:::	::::			::::	٦:::	H 03 03 93		::::	::":	: :m :	æ ;⊢ ;	::-::		::::	::::	::::	· · · · · ·	
O'Neill, Charles Orkney, Daniel C.	Free Church School, Jamestown, Dum-	• • •	::	::	::	::	::	<u>:</u> :	<u>ه</u> :	· :	H 69	::	::	٥٩ :	::	::	::	::	::	::	::	::	
Packer, Matthew W. Palmer, Joseph Parke, George H.	National School, Kinver Wells, Somerset 10, Mornington Place, Halinx	* : : :	<u> </u>	:::	:::	:::	:::	: : :	:e:	: 62	∞ ::	· : :	:::	a : w	: :07	:::	:::	:::	::: ::::	. : : :	:::	*:::	
Parker, Samuel I Parkhouse, Henry - Pascoe, John - Patchett, Issao - Pearce, Richard -	Trade School, Bristol Kingsbridge, South Devon- Green-coat School, Huntingdon Queenshead Schools, Halifax	: ; : : ; :	**::::	****	<u> </u>	:::;;	:::::	:::::	:::::	: ::	::::::	:::::	:::∺	:07::	:::::	:::::	:::::	-::::	:::::		11111	:::::	
Pearce, William Pearsall, T. J. Peile, Perctval B. B. Pepper, Charles Perkins, Frank P.	Maber Lodge, Portswood, Southampton London Mechanics, Institution South Rensington Museum St. Mark's College, Chilsea 21, Magdalen Street, Exeter	;;;;;		:::::	*****	:::::	:::∞:	:::::	:::::	64 : 64 : 5	:::::	::::	:::::	::::63	; ; ; ; 67	;::::	:::::	* * * * * * *	• • • • • • • • • • • • • • • • • • • •		*****	*****	
Perry, George W. Petritt, William Phillips, Harvey Pidgeon, Daniel Pike, Robert W.	Woodhouse Baves, Loughtorough S. Robert Street, Milford Haven Banbury Birkbeck Schools, Bethnal Green	*****	:::-:	:::::	:::::	:::::	:::::	:::::	::::09	::::=		:::::	:::::	::::	::::=	:::::	:::::	:::::	:::::			:::: -	
Pitt, Robert Plant, Edmund C Plant, John Prosser, William . Prokett, Joseph	Trade School, Bristol Royal Museum, Peel Park, Salford 14, Goldington Street, St. Pancras Road	:-:::	: : : :	:09 :::	:::::	:::::	:::::	: :::	:::::	:::::	69 : : : :	.0100001	:::::	:::∞∞	:::::	:::::	:::::		:::::	:::::	:::::	:::::	
Pullen, Moses Radford, Arthur	National School, Painswick, Strond 16. Sheffield Terrace, Campdon Hill, Kensington.	GR ; ,	:: '	:: '	::	::.	64 60	•• :	œ :					٦:	::	o1 ;	::	<u>::</u> ::	::	::	::	::	
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Sammons, Fred. H. C. Bamnelson, James Bamnelson, Newton Bantson, William Sarjeant, John	Saunders, Heary J. Saunders, James Scaping, Zebedee Schoffeld, Jahez C. Schoffeld, John	Scotson, James Scott, John Seaman, Isaac Senior, Thomas Severs, George	Sharp, Charles J. Shaw, Henry C. Shawcross, William Sheaf, Robert Shinn, Thomas	Shipman, Charles Shirley, James Bhore, Thomas W. Simpson, Bentham Sissling, William	Slater, James K.	Small, Hugh Smart, Herbert J Smeeth, Joseph F Smeeth, Rowland .	Smith, Joseph Smith, Joseph H.T. Smith, Mobert F. Smithies, Samuel Smyth, Andrew

٠.	Name.	Snell, Daniel - Snelus, George J. Sollas, William J.	Sparkes, Arthur J.	Spear, John J.	Speers, Adam Spencer, James Spink, John Spriggs, Christopher	Stanton, George	Stead, Wilbraham Stevenson, James Stevenson, J. M.N. Stewart, John Stles, James J.	Stirrup, Thomas Stockton, William	Stone, William - Strachan, Richard Strend, Robert -	Stubbs, Richard H. O. Sullivan, M.
	Address.	St. Mark's College, Chelsea 99, Great Marylebone Street, London 27, Oakley Road, Southgate Road, Isling-	National School, Albesbury, near Shrews-	Woodbine Cottage, Newtownirrey Road, Bray.	Holywood, County Down II, New Street, Charles Town, Halifax Cathedral School, Bipon 19, Henry Street, Chorlton-on-Medlock,	Berry Hill, Taplow, Maidenhead -	The Grammar School, Lincoln New Public School, Kilmarnook Carrickforgus Magdalen Chemical Works, Musselborough Sunderland	St. Mark's College, Chelses. 9, Montague, Place, Bast India Road,	St. Mark's College, Chalses	St. Margaret's School, Westminster 2, Brecon Terrace, Moore Park, Fulham
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SCIENCE AND ART DEPARTMENT OF THE COMMITTEE OF COUNCIL ON EDUCATION, SOUTH KENSINGTON.

DIRECTORY,

(Revised to August 1867.)

15th EDITION.

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REGULATIONS

FOR

ESTABLISHING AND CONDUCTING

SCIENCE SCHOOLS & CLASSES.

THE RULES IN THE PRESENT EDITION SUPERSEDE THOSE IN ALL FORMER EDITIONS, BUT ARE ALWAYS SUBJECT TO REVISION.



LONDON:

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PRINTERS TO THE QUEEN'S MOST EXCELLENT MAJESTY.

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SCIENCE AND ART DEPARTMENT.

COMMITTEE OF COUNCIL ON EDUCATION.

CROMWELL ROAD, SOUTH KENSINGTON.

Lord President, His Grace the Duke of MARLBOROUGH. Vice-President of the Committee of Council on Education, The Right Hon. LORD ROBERT MONTAGU, M.P.

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Assistant Secretary.—Norman MacLeod.

Chief Clerk.—G. F. Duncombe (pro tem.)

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Second-class Clerks .- A. H. |Gasparini ; C. A. Pierce, certificated in Art ; A. S. Cole, certificated in Science; also in Art; T. Chesman, B.A., LLB., certificated in Science.

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ART DIVISION.

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Occasional Inspectors.—S. A. Hart, R.A.; Eyre Crowe; F. B. Barwell. Official Examiner.—G. F. Duncombe.

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Provisional Librarian for Art Library. - R. H. Soden Smith, M.A., Trinity College, Dublin, F.S.A.

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South Kensington Museum-cont.

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Supplementary Assistant Keepers.—C. C. Black, M.A., Trinity College, Cambridge; R. F. Sketchley, B.A., Exeter College, Oxford; H. E. Acton; J. W. Appell, Ph. D.; A. C. King, F.S.A.; D. Craven. Clerk of Collections.—J. B. Rundell.

Supplementary Clerks.-H. Vernon; A. Masson; F. Coles, certificated in Science; F. Groser, certificated in Art; W. G. Johnson.

Agent for Sale of Examples.—J. Cundall.

Official Photographer.—C. Thurston Thompson.

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Deputy Head Master .- R. W. Herman.

Mechanical and Architectural Drawing .- H. B. Hagreen.

Geometry and Perspective.—C. M. Clarke.

Painting, Freehand Drawing of Ornament, &c., the Figure and Anatomy, and Ornamental Design.—R. Burchett, R. W. Herman; W. Denby; R. Collinson; C. P. Slocombe.

Modelling.—F. M. Miller.

Lady Superintendent of Female Students.—Miss Trulock. Female Teachers.—Mrs. S. E. Casabianca; Miss Channon. Lecturer on Anatomy.-J. Marshall, F.R.S., F.R.C.S.

Lecturer on Botany.—Christopher Dresser, Ph. D. Jena.

ROYAL SCHOOL OF NAVAL ARCHITECTURE AND MARINE ENGINEERING. Inspector-General and Director of Studies.—Rev. Joseph Woolley, LL.D.

Principal.—C. W. Merrifield, F.R.S.

Vice Principal.—Henry Martyn Taylor, B.A., Fellow of Trinity College, Cambridge.

Instructor of Naval Drawing.—W. B. Baskcomb. Instructor in Engineering Drawing. John Maxton.

Instructor in Marine Engineering .- J. F. Cotterell.

Instructor in Practical Chemistry.—John Davidson.

Instructor in French.—M. Penon.

Summary of the Nature and Amount of Assistance afforded by the Science and Art Department to the Industrial Classes in procuring Instruction in Science.

[Important Alterations made since the last edition of the Directory are printed in Italics.]

- I. A sum of money is voted annually by Parliament for scientific instruction in the United Kingdom.
- II. This sum is administered by the Science and Art Department.
- III. The head of the Education Department, of which the Science and Art Department is a branch, is the Lord President of the Council, assisted by a member of the Privy Council, who is called the Vice-President of the Committee on Education, and who acts under the direction of the Lord President, and for him in his absence. (Order in Council, 25th February 1856, Act 19 & 20 Vict. c. 116.)
- IV. The object of the grant is to promote instruction in Science especially among the industrial classes,* by affording a limited and partial aid or stimulus towards the founding and maintenance of Science schools and classes.†
- V. The payment of fees by the students can be looked upon as the only solid and students. Students. Sufficient basis on which a self-supporting system can be established and supported. Though

^{*} Direct payments are made to teachers only on behalf of adult artisans, or the children of artisans, or the children of persons who are not assessed to the income tax, that is, who do not possess an income of 100l. a year. (See § xviii.)

[†] The amount is liable to be decreased and eventually withdrawn. Payments to teachers therefore must not be looked upon as perpetual, or in any way conferring on the teacher a claim to any payments beyond those offered for each current year.

my Lords do not consider it necessary at present to lay down any rules making the payment of fees an absolute condition of the grants on account of Science instruction, yet as the payments from the State must be expected to diminish, and as aid on account of those persons who do nothing for themselves cannot be justified, Committees of schools and classes and teachers are strongly urged (should it at present not be the practice) at once to impose as high a scale of fees as they consider can be raised not only on middle class students but also on artisans.

VI. The following are the Sciences towards instruction in which aid is given:—

Subject 1, Practical Plane and Solid Geometry.

2, Machine Construction and Drawing.

,, 3, Building Construction or Naval Architecture and Drawing.

,, 4, Elementary Mathematics.

- ,, 5, Higher Mathematics.
- ,, 6, Theoretical Mechanics.

,, 7, Applied Mechanics.

- ,, 8, Acoustics, Light, and Heat.
- " 9, Magnetism and Electricity.
- ,, 10, Inorganic Chemistry. 11, Organic Chemistry.

,, 12, Geology.

"

" 13, Mineralogy.

" 14, Animal Physiology.

" 15, Zoology.

,, 16, Vegetable Physiology and Economic Botany.

,, 17, Systematic Botany.

" 18, Mining.

" 19, Metallurgy.

" 20, Navigation.

", 21, Nautical Astronomy.

" 22, Steam.

" 23, Physical Geography.

VII. The assistance granted by the Science and Art Department is in the form of—

1. Payments on results to teachers. (See § viii., xv., xviii. to xx.)

2. Grants towards the purchase of apparatus, &c.

(See § xxii.)

3. Public examinations in which Queen's Medals and Queen's Prizes are awarded, held at all places complying with certain conditions. (See § xi. to xvii.) On the results of these examinations the payments are made to the teachers. (See § xv., xviii., and xix.)

VIII. Persons are qualified to earn payments on results who have:—

a. obtained certificates as teachers in any of the before-mentioned sciences at the examinations for teachers of the Science and Art Department held previous to January 1867, or,

b. after the abolition of the above examinations—February 1867—obtained a First or Second Class

at the examination* specified in § x1.

No payments are made to a teacher on account of instruction given in subjects in which he is not so qualified.

IX. Suitable premises, with firing, light-sing, &c., must be found and maintained at the cost of the locality where the school or class is held. If at any time the funds do not cover these requisite local expenses, it must be inferred that there is no such demand as the Government is justified in aiding, for instruction in the locality; and the assistance of the Department will be withdrawn.

X. A Local Committee of not less Local Committee. than five well known responsible persons must be formed in connexion with every Science

^{*} Such examination may be dispensed with in cases where the candidate has taken a degree, the examination for which satisfactorily meets the requirements of the case. Full particulars must be furnished by the applicant, and his diploma sent for inspection.

Class, who will carry out the instructions contained in the Appendix.* (See pages 14 and 18 to 22.)

XI. The Science and Art Departof Classes. ment holds annually in May (see Science Form, No. 232, page 59*), through the agency of the Local Committees, a public examination of all Science schools and classes, whether taught teachers qualified as above or not, in any place in the United Kingdom which complies with the requisite conditions. (See § x., xiii., and xiv.) On the results of this examination the payments are made to qualified teachers. (See § xv. and xviii.) Application for it must be made before the end of March in each year, stating the number of persons and the subject or subjects in which they are to be examined. The form of application, Science Form No. 119 (see page 22*), will be sent on application to the Secretary, Science and Art Department.

In addition to the above, examinations in Mathematics, Navigation, Nautical Astronomy, Steam, and Physical Geography are held for the benefit of seafaring men—and for them only—three times a year in all seaports where Local Committees are formed and are willing to undertake them. These examinations take place in the beginning of March, September, and December. The application for these examinations must be made on Science Form No. 119 before the 10th day of the previous month.

Examination of Classes. XII. A school or class taught by a teacher not qualified to earn payments as above, may, by applying to the Secretary of the Science and Art Department, be examined at the same time and in the same manner as the classes under qualified teachers: provided that a Local Committee be formed which complies with the requisite conditions. (See Appendix, page 21,* Science Form, No. 88 a.)

If the class be for artisans the pupils are eligible

^{*} Science Directory.

to receive Queen's Prizes and Queen's Medals under the same condition as the pupils of qualified teachers. Should it however be for the middle classes the pupils are not eligible for prizes and medals, but receive certificates of merit instead.

XIII. If two or more classes in the same Places of town, or within a reasonable distance of one another, apply for the examination of the Science and Art Department, a general examination committee must be formed by the amalgamation of the several Committees to carry out the examinations at some common centre, such as the town hall or other public building. It is only when the classes consist of 50 or more candidates that such amalgamation of the committees will not at present be insisted on.

XIV. Any persons whatever, whether taught by the qualified teacher or not, students. may present themselves at the Local Committee's examination on registering their names in time for the Local Committee to comply with the instructions, and paying a registration fee of not more than 2s. 6d. each. Arrangements must therefore be made by the Local Committee, or the General Examination Committee, as the case may be, to enable other candidates, besides the students in the class for which the Committee act, to present themselves at this examination. The registration fee of 2s. 6d., which such candidates may be required to pay, is to reimburse the Committee for any extra expenses incurred by such attendance, and may at their option be remitted.

XV. The successful candidates at the Classification of Results. May examination and the quarterly examinations of seamen are classified under the heads of first, second, third, fourth, and fifth class. The standard of attainment required may be raised from year to year. For the fifth class it is only such as will justify the Examiner in reporting that the instruction has been sound, and that the students have benefited by it. Those who have attained a higher degree of

proficiency are classed as 4th, 3rd, 2nd, or 1st class,

according to their merit.

Queen's XVI. To the 1st, 2nd, and 3rd class are given Queen's prizes consisting of books or instruments chosen by the candidates from lists furnished for that purpose. These are unlimited in number, and are open to all candidates who come within either of the following categories, (1) Students in Science Classes under qualified Teachers; (2) Registered Students in Artisan Classes taught by any Teachers, or (3) bonâ fide Artisans.

Other candidates, if successful, receive instead

Cards of merit recording their success.

The following are exceptions to the above rule:—

a. Teachers earning or who have earned payments on the results of instruction; and

b. Students who have previously received the same,

or a higher class, in the same subject.

—the names of such candidates will simply be recorded in the published lists.

Queen's Medals. To the four best in each subject are awarded Queen's medals. These consist of one gold, one silver, and two bronze in each subject for competition throughout the United Kingdom. They are only awarded if there are a sufficient number of qualified candidates, and the gold medal will only be given in cases of high merit specially recommended by the examiner. The same candidate cannot obtain the same medal in the same subject more than once.

Only registered students of schools and classes under Local Committees (see § x. and xii.) are eligible for medals. They cannot be taken by middle class students who are more than 17 years of age or by teachers who are earning or have earned payments on the results of instruction. Students who but for this restriction would have taken the medal, will receive an honorary certificate instead. Should a student take more than one gold, silver, or bronze medal, he will receive books instead of a second medal.

XVIII. Payments are made to the Payments to teacher qualified as in § viii. on account of the instruction of students of the Artisan Classes (for definition of Artisan Class see Science Form No. 51, page 23) in the manner specified below:—provided that the student has received 25 lessons * at least from the teacher in each subject in which he claims payment since the last examination, each lesson being an attendance at a meeting of the school of at least three-quarters of an hour's duration on a separate evening. The 25 lessons need not necessarily be all given in one year, but may extend over a longer period.

XIX. 1l., 2l., 3l., 4l., 5l. are the claimable payments for each student in each subject, according to the class in which he passes, but these amounts may

be reduced in the following ways:

1st. If the student has been previously successful in the same subject, such payments are reduced by the normal payment which was claimable on such previous success; for instance, the 4*l*. payment for a second class would, if the student had previously taken a fourth class, be reduced by 2*l*.†

2nd. If a student be successful in more than one subject at an examination, the payments on account of such further subjects are reduced by one half.

3rd. When on this scale they would amount to more than 60l. the excess up to 40l. is diminished by one quarter, the excess above 40l. by one half. Thus payments which on the above scale would be 100l. and 150l. will be reduced to 90l. and 115l. respectively. ‡

† Deductions will be made in payments on account of Subject I. to the amount of any payments that have been made on Second Grade Examinations in Art, in practical geometry, perspective or mechanical drawing.

‡ Thus, 100, that is 60+40, is reduced to $60+40-\frac{1}{4}$ of 40 = .60+30=90. 150, that is, 60+40+50 is reduced to 60+30+25=115.

^{*} It must be clearly understood that the number (25) of lessons which the teacher is required to give is the minimum fixed as a criterion that the pupil has received his instruction from the teacher. It is not meant in any way to specify that that amount of instruction is sufficient, or to guarantee the teacher's receiving payment, if that amount of instruction alone is given.

If the teacher be instructing classes three miles or more apart this deduction will be reduced by the amount of his travelling expenses.

Form of Claim payment. XX. The claim of a teacher for the payments under these several heads is made on Science Form, No. 51, which will be sent on application. The voucher must be signed by the secretary and two members of the Committee of the Science Class or School; or by at least three of the Committee. (See Appendix, page 23.)

School Register. XXI. A school register must be kept in each subject on a Form which will be supplied on application. This must be made up from day to day, and will be examined and approved by the Inspector on his visit. It must be sent to the Department with the teacher's claim for payment, and no payment can be made unless it is properly kept.

Apparatus.

XXII. A grant towards the purchase of apparatus, diagrams, &c., of 50 per cent. on the cost of them, is made to Science Schools and Classes in Mechanics' and similar institutions with a properly constituted Committee (see § x.) A requisition must in these cases be made on Science Form No. 49. (See page 29.)

Instruction in an Elementary School.

XXIII. All payments to qualified teachers on account of Science teaching are made by the Science and Art Department, and are only made in respect of a school in connexion with the Science and Art Department. No such payments are made in respect of any instruction in Science that may be given during the three attendances of an Elementary School receiving aid from the Education Department, Whitehall.

Use of Elementary School Premises. XXIV. These grants are only made while the teacher is giving instruction in a day or evening school or class for the industrial classes (adults or boys), approved by the Science and Art Depart-

ment, and open at any time to the visit and inspection of its officers. The Managers of an Elementary School under the inspection of the Education Department can permit their premises to be used for Science teaching, provided that no interference be allowed with the primary purposes of such Elementary School, or in any way with the three attendances of the Elementary School.

- N.B.—On the next page will be found a table of memoranda for the use of Secretaries and Members of Science Committees (Science Form, No. 170) which it is expected will be carefully attended to. This, as well as the other Forms given in the Directory, can be had on application to the Secretary, Science and Art Department.
- *** The Directory for Science Schools and Classes is sold by Messrs. Chapman and Hall, 193, Piccadilly, London, or may be obtained from the Secretary, Science and Art Department, by enclosing six postage stamps.

APPENDIX.

SCIENCE FORM, No. 170.

MEMORANDA FOR THE USE OF SECRETARIES AND MEMBERS OF SCIENCE COMMITTEES.

Dates.

Constantly -

Before 1st January

Before 31st March

Before 24th April -

On the 27th April

During the May examinations.

On the evening of examination.

After the May examinations.

Before 30th Novem- Formation of Committee, Form No. 88. tinuation of Committee, Form No. 168.

To visit the School and see that the Register is kept from day to day, and that everything is regular.

To carefully fill in and send to the Department Form No. 120.

To send Form No. 119 applying for examination in

To see that Form No. 91 is hung up in the School-

If a parcel containing (1) the papers for the candidates to work upon, (2) copies of Form No. 91, one for each day's examination, and (3) envelopes in which to return the worked papers, should not have been received, or if there should be any mistake in the numbers sent for each subject as applied for, or in the covering letter, to communicate at once to the Department.

The examination papers for each evening will leave London by the night mail two evenings before, i.e., Thursday evening papers will leave on Tuesday evening, Friday's on Wednesday evening, Should they not arrive accordingly, a telegram to be sent at once to the Department.

The candidates, being all seated at 6.50, to read out the rules on Form No. 91, then give out the papers to be worked on. Then at 6.55 to break the seal of the examination papers and distribute to the candidates. To adhere rigidly to the rules on Form No. 91. To sign Form No. 91. To seal up the papers in one of the envelopes provided and at once post them.

On receiving lists of the results to give one copy to each candidate whose name appears in it as being successful; to inform the others they have failed.

To return Form No. 161 filled up as soon as possible in strict accordance with the rules on Form No. 110. (Prize List). To return Form No. 244a. To examine and certify Teacher's claims for payment, Form No. 51, and the School Register, which must be sent up at the same time. To return Form No. 108.

To keep a record of, and inform the Department of the number of individuals examined.

EXHIBITIONS AND FREE ADMISSIONS AT THE ROYAL SCHOOL OF MINES, LONDON.

ROYAL EXHIBITIONS.

1. There are eight Royal Exhibitions to the Royal School of Mines, Jermyn Street, of the value of 50l. per annum, entitling the holders to free admissions to all the lectures, and to the Chemical and Metallurgical Laboratories at the Royal School of Mines, to be held from year to year for three years, on the condition that the holder attends the lectures regularly during those years, and passes the examinations required for the associateship of the School.

At the May 1868 examination three of the above Royal Exhibitions will be open for competition independently of the prizes, &c. offered by the Science and Art Department.

All persons over 21 years of age, excepting artisans, and such as come within the category of persons paid upon under the Science Directory, will be excluded from competing for the Royal Exhibitions. Special cases, however, must be determined according to the spirit of the rules, and the object of the endowment.

The competition for the Royal Exhibitions will be determined by affixing the following values to the several results of the May examination (see Science Directory), viz.:—

To a 1st g	rade ir	n any subject	-	-	-	-	9 n	narks.
To a 2nd	,,	,,	-	-	- `	-	7	99
To a 3rd	,,	33	-	-	-	-	5	23
To a 4th	"	39	-	-		-		**
To a 5th	,,	,,		-	-		1	"
and in addition-								

For a gold medal ,, - - 10

For a silver medal ,, - - - 7

For a bronze medal ,, - - - 5

N.B.—Science Certificated Teachers may compete for the Royal Exhibitions. When coming up simply with this object, they should inform the Science and Art Department, so that their names may not appear in the published list with the students.

FREE ADMISSIONS.

2. Free admissions to the lectures at the Royal School of Mines, Jermyn Street, are granted to any person who takes a gold medal in the May examination.

But no candidate will be allowed to take a Scholarship who has not obtained at least a 3rd class in Elementary Mathematics.

EXHIBITIONS AND FREE ADMISSIONS AT THE GOVERN-MENT SCHOOL OF SCIENCE, DUBLIN.

ROYAL EXHIBITIONS.

1. There are ten Royal Exhibitions to the Government School of Science, Dublin, of the value of 50l. per annum, entitling the holders to free admission to all the lectures and to the chemical and metallurgical laboratories at the Government School of Science, Dublin, to be held from year to year for three years, on the condition that the holder attends the lectures regularly during those years, and passes the examinations required for the associateship of the school.

At the May 1868 Examination three of the above Royal Exhibitions will be open for competition, independently of the prizes, &c. offered by the Science and Art Department.

All persons over 21 years of age, excepting artisans and such as come within the category of persons paid upon under the Science Directory, will be excluded from competing for the Royal Exhibitions. Special cases, however, must be determined according to the spirit of the rules, and the object of the endowment.

The competition for the Royal Exhibitions will be determined by affixing the following values to the several results of the May Examination (see Science Directory), viz.:—

	To a 1st gr	ade in	any sub	ject -	•	- 9 r	narks.
	To a 2nd	39	"	•	-	- 7	99
	To a 3rd	,,	,,		-	- 5	,,
	To a 4th	99	,,	-	-	- 8	,,
	To a 5th	30	. 30	-	•	- 1	,,
and	in addition—						
	For a gold	medal		-	-	- 10	20
	For a silve	r med	al,	-	-	- 7	"
	For a bron	ze me	dal, "	-	•	• 5	**

N.B.—Science Certificated Teachers may compete for the Royal Exhibitions. When coming up simply with this object they should inform the Science and Art Department, so that their names may not appear in the published list with the students.

FREE ADMISSIONS.

2. Free admissions to the lectures at the Government School of Science, Dublin, are granted to any person who takes a gold medal in the May Examination.

But no candidate will be allowed to take a Scholarship who has not obtained at least a 3rd class in Elementary Mathematics.

FORM of APPLICATION for the ROYAL EXHIBITIONS to the ROYAL SCHOOL OF MINES, Jermyn Street, London, and the GOVERNMENT SCHOOL OF SCIENCE, Dublin.
The following candidates at the recent May Examinations are candi-
dates for the Royal Exhibitions at the*
and they are either—
1. Under 21 years of age.
 Or artisans or operatives in the receipt of weekly wages, supporting themselves by their own manual labour, or their children not earning their own livelihood.
3. Or, although not artisans, yet such as may fairly be considered as belonging to the industrial classes, as coming within one of the following categories, or being the children of such.
a. Though paid at longer intervals than a week, still supporting himself by his own manual labour and not by profit on the labour of others, that is, not employing apprentices, journeymen, etc.
b. Though not supporting himself by manual labour, yet being of the same means and social level as those who do so, (such as shopkeepers who have only petty stocks and employ no one but members of their own family,) policemen, coast-guards, etc.
c. Though not supporting himself by manual labour, yet such as it would be unreasonable to expect to pay the fee of middle class students, as some descriptions of clerks, shopmen, etc., and we certify that they or—in case they are not earning their own livelihood—their fathers are not assessed to the income tax.
4. That they are entitled to be considered as a special case on the following grounds:—
We hereby certify that the above particulars are correct. Chairman or Secretary.†
Two members of the Committee.†
* After each name must be stated all the successes of the candidate at the May Examinations and the category under which he claims.
† Should the candidate not have been a student in any Science School or Class under a regular constituted Committee, this voucher must be certified by three householders whose occupation and address must be given in full.

SCIENCE FORM, No. 88.

LOCAL COMMITTEES FOR SCIENCE SCHOOLS AND CLASSES.

- 1. A Local Committee of not less than five well-known responsible persons must be formed in connexion with every Science class, in order to comply with the necessary requirements of the Science and Art Department, and to carry out various arrangements on its behalf necessary for testing the efficiency of the science instruction, on the proof of which alone the aid of the Department is given.
- 2. The gentlemen proposed to act on this Committee are to fill in the form on the next page, stating their willingness to carry out the necessary arrangements for examinations, &c., and giving the address and occupation of each member.
- 3. The relation of the Committee to the teacher of a Science school or class will vary much according to the varying circumstances of different localities. In some places where the demand for science instruction is great, and there is an energetic local teacher to take advantage of it, the chief duty of the Local Committee may be to give the teacher the necessary vouchers for obtaining his payments. While in other places, where those who take an interest in and wish to further science instruction may, with that object, subscribe to and establish scientific classes either in connexion with an existing institution or not, and may engage a teacher certificated in science to instruct the classes, the teacher must, to a great extent, be the paid officer of the Committee. With these local arrangements the Science and Art Department does not interfere, but leaves them to the locality to settle. The local circumstances will determine whether, as in the first case, the master receiving the whole of the fees for instruction should provide at his risk the room for instruction, with the necessary firing, lighting, &c., or what, as in the second case, should be the proportion of the fees deducted on this account by the Committee.
- 4. The Science and Art Department requires that the Local Committee shall
 - a. Be responsible for the safe custody of all apparatus towards the purchase of which the Department has paid 50 per cent.
 - b. That they shall provide a room or rooms of sufficient size to carry out the annual examination according to the detailed regulations under that head. This examination is of all persons who wish to present themselves, and not only of those taught by the certificated teacher; but those persons who are not taught by the certificated teacher must send in their names before the 1st March, and may be required to pay a registration fee of 2s. 6d. for the whole examination.
 - c. That a school register, showing the attendance, number of lessons, payment of fees, &c., on an approved form, be kept properly filled up, and sent to the Science and Art Department when required.
 - d. That they shall send in to the Secretary of the Science and Art Department the list of students to be examined, before the end of March, specifying the subjects in which they are to be examined. That they shall be responsible for conducting and superintending the examination: giving out the examination papers which will be

- sent for that purpose: seeing them worked fairly and certifying to the same, not less than three of the Committee being always present: and sending the worked papers, under seal, by the day's post to the Secretary of the Science and Art Department.
- e. That they shall certify, firstly, that those students on whose examination the teacher bases his claim to payments on results, are artizans or operatives, or their children, or can claim as such (see Science Form, No. 51; and, secondly, that they have received 25 lessons at least from the teacher in the year or since the last examination, on their passing at which payment was claimed on their account.
- 5. The Science school or class must be at all times open to the visit and inspection of the officers of the Science and Art Department as a condition to the grant of aid from it; if at any time it is found that the apparatus, &c., towards the purchase of which a grant has been made is not properly taken care of, or that a proper room with firing, lighting, &c., is not provided for the class, the aid of the Department will be withdrawn.

NOTE.—As it is to the Committee that the Department looks to carry out the great proportion of the duties of the school, as many as possible of the members of the Committee should attend on the inspector's visit.

Form of Application to act as a Committee for a Science School of Class. We the undersigned.

[f. The Committee shall be composed entirely of well-known responsible persons of position who are quite independent of the school or class, and who have no such personal interest in it as can lay them open to the slightest suspicion of partiality; and of course no member should be connected with the Teacher, have any pupils for examination, or be a pupil himself.

g. It is very desirable that as many persons as possible in recognized positions of public responsibility in the district, such as Magistrates, Municipal Authorities (Mayor, Aldermen, or Town Councillors), Heads of Educational Establishments (Trustees of Grammar Schools, Managers of National Schools), Clergymen, &c., should be on the Committee.

h. It is absolutely necessary that at least two such responsible persons should agree to act.

agree to act.

i. The Committee must consist of a Chairman, Secretary, and at least three other

Members.

The Chairman must be a Magistrate, Mayor, Boroughreeve, Provost, or Alderman, or other public officer of recognized position, Trustee of Grammar School, or Clergyman of the Established Church in parochial employment.
 The Chairman of the Committee will inform My Lords as to the constitution of

1. The Chairman of the Committee will inform My Lords as to the constitution of the Committee being in accordance with these requirements.
m. The Secretary of the Committee of the Science School or Class, as being the medium of communication, will carry on all correspondence with the Science and Art Department, and is held responsible for making out and sending all returns required, for the receipt and distribution of the examination papers, the transmission of the worked papers, &c., at the proper times according to the regulations; and in consequence of the necessary demands on his time and trouble My Lords have sanctioned, provisionally, the payment to him of the following fees: —1.4 annually for furnishing the returns, &c. specified on Science Form, No. 170, connected with any Science school or class, and 1l. in addition for each day's examination held by the Committee to which he is Secretary. The Secretary must be a member of the Committee; the requirements in par. 1 apply equally to him.
7. This form is to be filled in and returned to the Department annually before the 18th December, except in the case of new schools or classes, when it should be made as soon as they are formed.]

propose to act as the Local Committee for the Science Class held at

· · · · · · · · · · · · · · · · · · ·		_
and taught by		
	- ·	

We undertake for the year at least, and further till another Committee satisfactory to the Science and Art Department has been appointed,

- To be responsible for the safe custody of all the Apparatus, Diagrams, &c., towards the purchase of which the Department has in any way contributed.
- 2. That three or more of our number will be ready at the appointed time to be present at, and superintend, the examinations of the Science Class according to the instructions of the Science and Art Department, and give the teacher the necessary vouchers.
- 3. That a room or rooms shall be provided for the due carrying out of such examination, according to the rules of the Department, providing sufficient space for the examination, not only of all persons taught by the certificated teacher, but of all others who may wish to attend the examination.
 - (A fee of not more than 2s. 6d. may be charged on each applicant for examination who is not a student in the class, to reimburse the Committee in any extra expenses they may be put to in providing a room).
- 4. That the School or Class shall be open at any time to the visit and inspection of the Officers of the Science and Art Department.

Signature.	Address.	Occupation, specially stating how fulfilling the conditions of "g." and "k." above.
Chairman.		
Secretary.		

I certify that this Committee complies with the requirements of the rules f, g, h, i, and k.

Chairman.

The Secretary,

Science and Art Department.

This form may be had on application to the Secretary, Science and Art Department, South Kensington.

SCIENCE FORM, No. 168.

Where the same Committee proposes to act again it will not be necessary to re-sign the above, No. 88, but only to hold a meeting and fill up this form, No. 168, which may be had on application.

SCIENCE FORM, No. 88 a.

LOCAL COMMITTEES FOR SCIENCE SCHOOLS AND CLASSES NOT RECEIVING AID FROM BUT EXAMINED BY THE SCIENCE AND ART DEPARTMENT.

This Form is a modification of the previous, No. 88., and may be had on application to the Secretary, Science and Art Department, South Kensington.

SCIENCE FORM, No. 120.

SCIENCE CLASSES UNDER CERTIFICATED TEACHERS.

Annual Report of Science School or Class,

To be made on its establishment, and annually (before the 1st January) of its

continuation.

Place, as Mechanics' Institution, &c., in which the Classes are held

Name of Town

, No.,	, &c			····
ier or	Teachers_			
addre	88 e 8		·····	
		_		
Fees.	No. of Students.	Days on which they meet.	Hours of Meeting.	Period of the Year during which the Classes continue.
	er or iddre rotal	Addresses	rotal No. of individual Students_ ttends two or more classes he must of	rer or Teachers ddresses Total No. of individual Students ttends two or more classes he must only be coun No. of Days on which Hours of

NAMES OF SECRETARY AND MEMBERS OF THE COMMITTEE.

(The undertaking on Science Form, No. 88, is for the year at least, and further till another Committee satisfactory to the Science and Art Department has been appointed. This Form, No. 88, must therefore be filled in and sent to the Department annually when the class recommences, except in those cases in which the whole of the Committee, wishing to continue, formally authorize the Chairman and Secretary to report to that effect. It will then only be necessary for new members to sign the form undertaking to perform the various duties.)



SCIENCE FORM, No. 119.

SCIENCE SCHOOL FOR EXAMINATION IN MAY.

To be sent to the Secretary of the Science and Art Department before the end of March.

APPLICATION FROM

1			· · · · · · · · · · · · · · · · · · ·
	·IIIXX	Physical Geo- graphy.	
	IIXX	Steam.	
	TXX	Nautical Astro- nomy.	
	XX	General Maviga- tion.	
i	XIX.	Metallurgy.	
	THAX	.BaiaiM	
	ПЛХ	Systematic Bo- tany.	
	TAX	Vegetable Physi- ology and Beo- nomic Botany.	
	.VX		
3	.VIX	-isvaf LaminA ology.	
1	·IIIX	Mineralogy.	
5	TIX	Geology.	
	TX	Organic Chemia- try.	
	ж.	-odo oinssronI rainistry.	
1	TI	Magnetism and Electricity.	
	TIIA	Acoustics, Light, and Heat,	
3	та	Applied Mecha- nica,	
} }	'IA	-old insidercent	
	Λ.	Higher Mathe- matics.	
	.VI	Elementary Ma- themstics.	
3	ш	Building Construction,	
To be sent to the position and position and true polyment position and of the sent of the	π	Mechanical and Machine Draw- ing.	
3	т.	Practical, Plane, and Solid Geo- metry.	
•			Number of students under in- struction during the year Number intending to present themselves for examination Number intending to present themselves for examination not belonging to the class

Name and address of the person to whom the examination papers are to be sent.

N.B.—The address must be that to which the Examination papers are to be sent.
Specify here the arrangements which have been made in accordance with § XIII. of the Science Directory to conduct the examination of any other classes in the town (if there be any) at the same centre.

The total number of individual students only should be here given, so that if one student attends two or more classes he must only be counted as one.

SCIENCE FORM, No. 51.

SCIENCE AND ART DEPARTMENT OF THE COMMITTEE OF COUNCIL ON EDUCATION, SOUTH KENSINGTON.

Appli	cation from			_ Scien	ce Teac	her in	
School o	r Institution					or payment.	
On be		Com	mittee of Man	agemen	t of th	is School, We do	hereb y
				e Teac	her in	formed the various the School, dur	
(3). '	he year, or on their according That the un receipt of a	since ount, ider-r veekl	the last examin each subject mentioned study wages, support	ination t for when the second tents are second to the second tents are second tents are second tents are second tents are second tents.	at which hich pay e artizat hemselve	least 25 lessons the payment was yment is claimed us or operatives to by their own	claimed . * in the
•	abour; or t	neir c	hildren not ear	ning the	ir own l	ivelihood. Secret	ary.
					•	} t	o mem- ers of nmittee.
N.B.—Ti der in	NAMES the names of	OF I	PASSED ARTIZA students must be placed his sever- the amount claim	NOR O	PERATIF	Те	acher. each stu- ne); and ne proper
urname.	Christian Name in full.	Age last Birthday.	Trade, or father's trade. (State which	Exam:	ion at late ination.	Highest Position in same Subject at any previous	Pay- ment claimed.
			is given).	Subject.	Grade.	Examination.	
	ļ	_					
	-	-					
&c.							

^{*} Should the Teacher have instructed any Students who may fairly be considered to belong to the industrial classes, but whose wages are paid at longer intervals than a week, or who do not support themselves by their own manual labour, the claims on their account must be made by the Committee of the school on the form on page 3, when they will be considered on their merits.

a. T b. T c. T We cer (1). (2). (3).	ng categor hough paid his own m is not emp hough not means and have only family), po hough not be unreaso some descrify to the That he is the last en in each sul That they, fathers are	ging ies, or lat l anual loyin supp sociu petty plicen supp nable iption best as giv as giv anual follov	to the industre to the industre reing the chill longer interval labour and n g apprentices, jorting himself at level as thored in the constant of the constant	ial classifier of s than a cot by property by man se who aploy notes, &c. by man pay the copmen, lessons a h paymement is re not es income	ses, as consultation week, a second on the second of the s	our, yet being of nich as shopkeep out members of to our, yet such as middle class st during the year claimed on their	ne of timself thers, to the so ers (wheir o udents, or sir account to the transmission of transmission of the transmission of transmis	by hat time who will do not be
	••						retary. wo me bers c	em-
T1			the following				ommit	
N.B.—T	ime must be	place	d his several succ	cesses (if	he has m	etically. After each	l in the	nt's last
Surname.	Umn the an Under the Christian Name in full.	Age last Birthday.	Trade, or father's trade. (State which is given).	Posit the Exami	ion at late nation.	Highest Position in same subject at any previous Examination.		
co	Under the Christian Name in	ge last rthday.	Trade, or father's trade. (State which	Posit the Exami	ion at late	Highest Position in same subject	Do	
co	Under the Christian Name in	ge last rthday.	Trade, or father's trade. (State which	Posit the Exami	ion at late nation.	Highest Position in same subject		
co	Under the Christian Name in	ge last rthday.	Trade, or father's trade. (State which	Posit the Exami	ion at late nation.	Highest Position in same subject		
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&c. Surname. &c. The Sec.	Christian Name in full.	Art I Birthday.	Trade, or father's trade. (State which is given).	Posit the Exami Subject.	ion at late mation. Grade.	Highest Position in same subject	State Gategory 8, b, or c.	Page



[SPECIMEN.]

Science Form, No. 51. South Kensington, July 1865.

SCIENCE AND ART DEPARTMENT OF THE COMMITTEE OF COUNCIL ON EDUCATION, SOUTH KENSINGTON.

Application from John Smith, Science Teacher in the Science School or Institution at Midhurst for payment.

On behalf of the Committee of Management of this School, We do hereby certify:—

That Mr. J. Smith has duly performed the various duties devolving upon him as a Science Teacher in the School, during the year ending 31st day of May 1865;

(2.) That he has given the following Students at least 25 lessons during the year, or since the last examination at which payment was claimed on their account, in each subject for which payment is claimed:

(3.) That the under-mentioned students are artizans or operatives* in the receipt of weekly wages, supporting themselves by their own manual labour; or their children not earning their own livelihood.

Wm. Brown, Secretary.

John Jones, Two members of Committee.

I hereby certify that the following particulars are correct.

John Smith, Teacher.

Names of Passed Artizan or Operative Students.*

N.B.—The names of the students must be arranged alphabetically. After each student's name must be placed his several successes (if he has more than one); and in the last column the amount claimed on each success after making the proper deduction.

Surname.	Christian Name in full.	Age last Birthday.	Trade, or father's trade. (State which is given).	Position the last Examina Subject.	ate	Highest Position in same Subject at any previous Examination.	Payment claimed.
Adams, " Barber, Smith,	James, " John Wm. Henry. William,	22 " 14 12	Carpenter, " Butcher (f) Baker (f)	X. XI. XIV. X. XI.	1st 2nd Pass 1st 4th 1st	4th — 2nd — —	£ s. 5 0 1 0 0 10 0 10 2 0 5 0

Should the Teacher have instructed any Students who may fairly be considered to belong to the industrial classes, but whose wages are paid at longer intervals than a week, or who do not support themselves by their own manual labour the claims on their account must be made by the Committee of the school on the form on page 3, when they will be considered on their merits.

SCIENCE FORM, No. 108.

Application from		Secretary of the Local
Committee for the Scien	nce School or Class at_	
for payment of allowan	ce for duties connected	with the School, and for
superintending the exam	mination.	
Sir.		
Being entitled t	o payment according to	the regulations of the
		ith the Science Class at
		tending the arrangements
for carrying out the exa	minations on	the following days
		may
be paid to me, being the	authorized fee.	
Dates of Examination.	Dates of Examination.	Dates of Examination.
		
		
	····	
		·
		
		
·	I am, Sir,	
	Your	obedient Servant.
The Secretary,		
Science and Art D	epartment.	
	•	
CONDITIONS	: A	
&c. MAY BE OBT	TAINED BY SCIENCE	Instruments, Books, Schools or Classes ED in Science),† in

^{1.} The Lords of the Committee of Council on Education, having had under their consideration several applications from the managers and masters of Mechanics' and other Institutions, for grants to be made to them of Apparatus and Illustrations, recommended by the Science and Art Department for teaching science, think it necessary to adopt some general principle which shall regulate the decisions of the Committee in reference to such applications.

^{* £1} annually for furnishing the returns, &c. specified on Science Form No. 170, connected with any Science school or class, and £1 in addition for each day's examination held by the Committee to which he acts as Scoretary.

† Apparatus not exceeding 10L in value may be obtained by poor Schools and Mechanics' Institutes, not taught by a certificated teacher, under the same conditions, that is, the Department will aid them to the extent of 5L.

Their Lordships have already fully recognized the great importance of practical science to all classes of the community, in all relations of life. They are, therefore, desirous that the Science and Art Department should assist, as far as possible, in promoting the distribution of diagrams and apparatus as the means of accomplishing this object; but as the indiscriminate gift of these aids for instruction to all applicants might lead to abuse, it is necessary to require some guarantee that they will be duly appreciated, which the mere request to have them does not imply.

The principle which governs the whole proceedings of the Department in all its branches is to afford partial aid, and to encourage, but not supersede public exertions in promoting education in science. They have, therefore, resolved that the Department shall have the power to assist schools and classes taught by a certificated teacher in Mechanics' and other institutions in purchasing diagrams and apparatus for teaching science at a reduction of 50 per cent. on the net cost.

Lists of the scientific diagrams and apparatus prepared by the Department, according to conditions of the following Minute, may be obtained of the Secretary of the Science and Art Department, South Kensington, London, W. It should be distinctly understood that the aid of the Department in purchasing these articles at a reduced price, if above 101. in value, can be granted only to public schools and institutions when taught by a certificated teacher.

Minute of the 23rd March 1860.

"The Lords of the Committee of Council on Education desire to afford the greatest facilities to teachers of science and navigation schools in obtaining the best instruments, apparatus, &c., for giving instruction in science and navigation, towards the purchase of which the Science and Art Department is authorized to pay 50 per cent. of cost; and they consider that the fullest opportunities should be given to manufacturers in all parts of the Kingdom for supplying such apparatus, &c. At the same time it is necessary that the Science and Art Department should have some guarantee that the apparatus and instruments are of good quality, and moderate in price. My Lords have therefore laid down the following rules and conditions:—

- "1. Samples of all articles on the manufacturer's list are to be sent to the Educational Collection, South Kensington Museum, for exhibition, where they will be arranged separately, according to the science for which they are intended, so as to afford teachers and others facility in inspecting them and making a choice.
- "2. The manufacturer is to supply priced catalogues of such articles printed in demy 8vo., in order that the various catalogues may be bound up together and supplied when asked for.
- "3. The manufacturer is to guarantee that the articles exhibited are fair samples of those specified in the priced catalogue, and he must engage to take back any article supplied to schools which may be inferior to the standard."

Manufacturers willing to comply with these conditions are to make a statement to that effect, and to send lists of apparatus, instruments, books, &c. in the following sciences:—1. Practical plane and descriptive geometry, mechanical and machine drawing, and building construction; 2. Physics (mechanical and experimental); 3. Chemistry; 4. Geology and mineralogy; 5. Natural history (zoology and botany, vegetable and animal physiology); 6. Navigation and nautical astronomy, and physical

geography. If these lists and prices are such as can be approved of, the manufacturer will be informed, and as soon as possible on his fulfilling the conditions, his list will be inserted in the catalogue. The catalogue will undergo a revision at least once a year, when manufacturers may send any improved forms of apparatus, &c.

The selection of the manufacturer will lie wholly with the Committee of the school. On their demand being sanctioned, the manufacturer will receive instructions to supply the articles upon his receiving the 50 per cent. due from the school.

On obtaining a receipt from the Committee of the school (which is included in the form of the requisition) that the articles have been received, the remaining 50 per cent. will be paid quarterly to the manufacturer by the Department.

2. Payments, including charge for packing, must be made in advance to the agents on receipt of the invoice. The goods to be sent at the risk of the purchaser.

All communications to be addressed to the Science and Art Department, South Kensington, London, W.

By Order of the Committee of Council on Education.

N.B.—Apparatus grants will in future be rigorously confined to articles of a permanent and non-destructible nature; hence no aid will be afforded in the purchase of breakable articles, such as glass retorts, test tubes, &c., or, indeed, generally in the purchase of articles to be used by the student as distinguished from those of a permanent and illustrative character which are required by the teacher in giving instruction in science.

Grants are only made in the purchase of one object of the same kind. Duplicates of apparatus, &c. are not allowed at the reduced rate.

SCIENCE FORM, No. 49.

FORM of REQUISITION which may be had on application to the Secretary, Science and Art Department.

The following Requisition for Aid in purchasing apparatus, &c., after being filled up as required, is to be transmitted to "The Secretary of the Science and Art Department, South Kensington, London. W."

N.B.—It is to be understood that the Department has a lien on the apparatus, &c., furnished to public institutions to the amount of the public aid given in supplying them: they cannot therefore be sold.

them; they cannot therefore be sold.		
1. Requisition for AID in purchasing apparatus, &c. For the use of School or Instituti	ion (a) c	No. 1 appli-
In the City or Town of (a)		illed in by
In the County of	<u>I</u>	Requisition-
Male Female	i	st, with ull par-
mate Lemate	t	iculars.
(a) Erase the words that		, , , , , , , , , , , , , , , , , , ,
do not apply. (a) Scholars or Members of Poor School of chanics Institute.	or Me-	
Total.		
I request the aid of the Department in obtaining from M		
the apparatus, &c., named in the opposite page, and I undertake that the same sleept and used in the above-mentioned (a) school or institution for which they been demanded. The address to which the parcel is to be sent is as follows:—	hall be have	
To be forwarded toatatatat		
Signature of Dequisition	nist.	
Dated thisday of16	86 .	•
2. Requisition sent to M day of 186 ,	Agent.	No. 2 to be
this day of 186		filled in by the Depart.
and authority given for the supply of Articles to the extent		ment.
Net Sum		
of which & will be paid by the Department, and & togethe the cost of packing, by the school or institution, previous to the goods	r with being	
appliedAssistant Secret	tary.	
3. Invoice of articles sent to Requisitionist as under, this		No. 3 to be filled in by
Articles (Retail Price) £	1 :	agent on transmis-
Aid by Department	1 :	sion of the invoice.
Add, for packing		
Total to be paid by Requisitionist		
A Amount 0 marinal from schools this	- 	Nou Aand B
4. Amount 2 received from schools this 186 .	-uny or	to be filled
A	gent.	in by agent.
5. Examples forwarded as directed above, together with Requisition, this ————————————————————————————————————		
6. Examples as per invoice received, and *Requisition returned to Agent, this—day of———186 .	gent.	No. 6 to be filled in by
Requisition———————————————————————————————————	onist.	Requisition ist.

 $^{^{\}bullet}$ It is requested this paper may be returned to the Agent in an entire state after the examples have been received.

SCIENCE FORM, No. 91.

RULES FOR THE CONDUCT OF SCIENCE EXAMINATIONS.

1. The following rules must be hung up in the examination room for the information of the candidates one week before the examination. They should all be carefully read by the members of the Committee. Those marked with an asterisk must be read aloud before the Committee and the candidates on each night immediately before the examination

2. A room or rooms of such a size that, when seated, the candidates shall be at least five feet apart, from centre to centre, must be provided

for the examination.

3.* All Diagrams, &c. must be removed from the walls of the examination room.

4. Ink and blotting paper must be provided. All arrangements for the accommodation of candidates must be completed by 6.30 p.m.

5. If one room is used three of the Committee must be present during the whole of the examination, if more than one room then two of the Committee per room, who must carefully watch the whole examination and see that candidates use no unfair means either by assisting one another or using books or notes. The members of the Committee can, if they wish it, relieve one another, so long as the correct number are always present. No persons not on the Committee are permitted to be present.

6. The examination papers will be forwarded, under cover, to the Secretary of the Committee so as to be received by him on the morning

of the day before that fixed for the examination.

7.* The candidates must be seated at their places at 6.50 p.m. this time no candidate shall be admitted except under very exceptional circumstances, and that only by express permission of the Committee, and if no person who has seen the examination paper has left the room. No candidate may on any account be admitted after 7.30 p.m.

8.* The examination papers must be opened in the examination room in the presence of the Committee, at 6.55 p.m. No examination paper

may be taken from the room till after 8 p.m.

9.* When the candidates are seated and the papers given out, the Committee will see that the candidates commence by filling in their names, &c., where directed. All the worked papers must be collected at 10 p.m., initialed, put under cover, and sealed in the presence of the members of the Committee; and forwarded by the first post to the Secretary of the Science and Art Department.

10.* Candidates must on no account bring anything with them into the examination room, texcept pens and pencils. No scribbling paper, slates, or anything of that nature must be allowed. Arrangements must be made by which all books, note-books, &c., can be given up and left at the

door.

11,* Candidates must not on any pretence whatever speak to one another after the papers have been given out. If a candidate should require to ask a question, he will hold up his hand, when a member of the Committee will attend to him, but no question on the meaning of any portion of the examination paper must be asked or answered.

12. It may be of service to the Committee that the teacher of the

[†] When there are not more than three candidates it will not be necessary for more than two members of the Committee to be present at the examination.

‡ Except such as by the Time Table (Science Form, No. 90) are required.

§ It is absolutely necessary that nothing that can be passed from one candidate to another should be allowed. Rough work and calculations must be done on the supplied form, the back of each leaf of the form, i.e., pages 2, 4, 6, and 8, may be reserved for this purpose, the pen being drawn through to show that they are not for the examiner. But nothing must be torn off the form. nothing must be torn off the form.

class should attend before the examination begins to assist in getting the candidates into their places, &c.; but from the peculiar character of the examination it is so very necessary that not the slightest opportunity for misconstruction should exist that it is evident that he should not be in the room after the examination papers are opened. Information of his having remained in the room after this will at once lead to the examination being declared null.†

13.* The examination papers being given out no candidate must be allowed to return after having once left the room.! On a candidate

leaving the room his papers must be taken up.

14.* At 10 p.m., precisely \$\\$, all the candidates must cease working, and members of the Committee will collect their worked papers from them at their places. It will therefore be advisable to warn them ten minutes before the time. The papers will be initialed, by the Committee as directed, as they are received from each candidate, as a guarantee that each has been worked by him whose name, &c. it bears. Should a candidate have completed his work before 10 p.m. he may, by permission of the Committee, go away at once, after his worked paper has been taken by a member of the Committee.

15.* Should a candidate break any of the foregoing rules, ask from or give information to another, or use unfair means of any description, he must be at once expelled the examination room, and his paper cancelled,

and the Committee will state on it the cause of his expulsion.

16. On these examinations depend large grants of public money. On their being fairly, honestly, and impartially carried out depends the continuance of the system. The Committees are intrusted with this duty. They will see, then, how necessary it is to be extremely careful in conducting them, and to insist on the foregoing rules being complied with to the letter. They are therefore required to sign and forward this form with each set of worked papers.

We, the undersigned, memb School or Class held at	pers of the Committee	of the Science
hereby certify that we were	held in the	
on the evening of the papers were worked in our presented with.	where the ence, and that the foreg	he accompanying going rules have
Dated this	day of	186
Signatures.		Time Present.
	•	
		_

retire within the room.
§ Except in the Drawing Examinations, subjects 1, 2, and 3, then the hour is 11 p.m.

[†] Should the teacher of the class wish to compete at this examination for the Royal Exhibitions, he must apply specially to the Committee for permission, so that they may arrange to have a table for him close to their own seats, and not with the other candidates.

11 will, therefore, be desirable to make some arrangement for the candidates to

SYLLABUS OF THE SUBJECTS IN WHICH EXAMI-NATIONS ARE HELD BY THE DEPARTMENT OF SCIENCE AND ART.

THE following Syllabus has been prepared in order to afford candidates some guide to their reading; but it must be understood that the questions in the examination need not necessarily be on the specific points

enumerated.

The examination is by paper, but oral examination may be resorted to. The examination in each subject is distinct. Mention is made of textbooks solely to afford a candidate some assistance in selection and a general idea of the scope of the examination, and not at all to confine his reading to those works or to assert that they are the best on the subjects

they treat of.

A Course of Lectures as detailed below, on "Preparation for obtaining "Science Certificates and the Method of teaching a Science Class," has been delivered by direction of the Lords of the Committee of Council on Education. The lectures may be purchased, price 2d. each, at the book stall, South Kensington Museum, or on application by letter, enclosing postage stamps, to the Secretary, Department of Science and Art, South Kensington, London, W.

Geometrical Drawing, &c. Prof. T. Bradley.

Mechanical Physics - Rev. B. M. Cowie, M.A. Chemistry -- Prof. Hofmann, F.R.S. Geology - Prof. Ramsay, F.R.S.

- Prof.W. W. Smyth, M.A., F.R.S.

Mineralogy, &c. - Prof. Huxley, F.R.S. Zoology

Botany - Edwin Lankester, M.D., F.R.S. Navigation and Nautical J. Riddle, F.R.A.S.

Astronomy.

Physical Geography - Dr. G. Kinkel, F.R.G.S.

A Second Course has been delivered, of which the following have been published:—

Lecture I. - Vegetable Physio- Edwin Lankester, M.D., 3rd February. logy and Econo-F.R.S. mic Botany.

Lecture II. Mechanical Physics Rev. B. M. Cowie, B.D. 10th February. - W. W. Smyth, M.A., 24th February. Lecture IV. Mining F.R.S.

SYLLABUS.

A teacher will not receive any payments for Subjects II. or III. until he is qualified in I.

Subject I.-Practical Plane, and Solid Geometry.

Practical Geometry, plane and solid; required by architects, engineers, mechanists, shipbuilders, and others employed in arts of construction.

The candidate is assumed to have acquired readiness in the use of the usual drawing instruments and materials, to be skilful in drawing lines and circles in Indian ink, plain or dotted, of different degrees of fineness; drawing parallel equi-distant lines, at least six inches long, and from five to twenty or thirty in an inch; drawing from ten to thirty lines, passing through one point and forming equal angles; dividing by trial lines and arcs into any number of equal parts. He should also be able to mend his drawing pens and other instruments, and to verify his rulers, &c. Two or three questions in the first or easy paper are intended to test his skill in these respects.

Constructions in Plane Geometry.

 To draw lines through given points, in every position, either parallel, perpendicular to, or to form any proposed oblique angle, with given lines.

The use and construction of the protractor, and of the "scale of chords" for these purposes, should be understood, and the deduction of certain angles from the direct division of the circle.

2. To draw circles or arcs, through given points, to touch given lines or circles, and, conversely, lines to touch circles.

Required in drawing framework for machinery, architectural designs, ornamentation, &c.

3. The principles of drawing symmetrical forms by means of co-ordinates to the axis of symmetry.

This is the basis of all drawing, of objects of construction, which are always symmetrical, not only in architecture, civil and naval, but in machinery and engineering works of all kinds.

 Constructions of figures similar to given rectilinear or mixtilinear figures.

Here the construction and use of "scales" plain and comparative, should be thoroughly understood and explained, and the principles of the diagonal division of scales. Also the mode of reducing or enlarging drawings by means of similar rectangles, termed squaring a drawing. The use of the sector and of proportional compasses in facilitating copying should be known.

- To construct rectilinear figures similar to given ones, but with a proposed area.
- 6. To determine by construction numerical quantities such as \sqrt{m} ; $\sqrt{\frac{1}{m}}$; $\sqrt{a^2 + b^2}$, &c.

- 7. To construct a triangle, any three parts being given.
 - § 1. Used in levelling, surveying, and the determination of heights and distances. Great accuracy, neatness, and distinctness of construction, will be insisted on: Geometrical drawing is valueless unless it possesses these requisites.
 - § 2. A few illustrations of constructions on the ground, by means of a "chain," pins and cords, necessary in surveying, and "setting out" buildings and earthworks, may be added to the course, as well as the solution of a few elementary problems by means of the compasses alone.
- 8. The delineation of a few of the curve lines required in the arts, such as the ellipse, cycloidal curves, the involute and sinusoid, with the graphical method of determining their tangents and normals.

Required in designing elliptic arches, oblique bridges, teeth of wheels, cam-work, screws, &c.

 Practice in tinting and shading with Indian ink, so as to express curved surfaces and shadows.

Both papers contain questions from sections, 1, 2, 4, 5, but those of the second or more difficult paper are chiefly from sections 4, 5, 7, and 8, and only rarely from 3, 6, 7, and 9.

For the preceding part of the course, a fair knowledge of the first four books of Euclid is necessary, some acquaintance with elementary trigonometry is also desirable.

Constructions in Solid Geometry.

(Descriptive Geometry.)

- A general knowledge of the principles of projection on two (co-ordinate) planes, as necessary to define or represent any geometrical solid, is necessary to gain any certificate in this subject. These projections are termed plans, elevations, profiles, or sections.
- The questions in the first or easy paper demand only this elementary knowledge, the candidate being required to represent by their projections simple solids, such as prisms and pyramids, or others formed by their combinations.
- But to obtain a second or first class the candidate must be acquainted with the methods of solving problems on the combinations of points, lines, and especially planes, independent of any solid form or volume of which they are the elements.
- He should also know something of the geometry of curved surfaces, as the sphere, cylinder, and cone, and of the mode of representing all surfaces graphically by the projections of their generators. For the following subjects he must know how to determine planes to touch or tangential to such surfaces; but candidates are not expected to be more than generally acquainted with these subjects. Occasionally, however, easy questions in the following are inserted in the second paper.
- Applications to the intersections of surfaces, and of the development of such as admit of it.

This may be considered the most important part of descriptive geometry to the artizan, as it is required in all arts of construction. The mason, carpenter, and shipwright, workers in tin-plate, boiler makers, &c., must all possess some knowledge of it.

The solution by construction of the spherical triangle from any three given parts, is mentioned.

As important to masters, mates, and others engaged in any kind of astronomical calculations.

Isometric Projection

Is usefully employed in the representation of works, chiefly of a rectangular form, such as timber framing, canal-locks, and many parts of machinery; its use is increasing: it is readily understood, and can be practised by anyone who has gone through the previous articles of this section.

, Perspective or Radial Projection

- May be taken up, but will not be insisted on as it is rarely used except by architects to represent buildings (not yet executed), as they would appear to the eye at any spot from which they could be viewed, and the power of applying it for this purpose is possessed by many who know little of the really easier subject of descriptive geometry; but as its application by the architect must be subordinated to artistic taste, this consideration excludes it, in some measure, from a purely geometrical course.
- No one, however, can be considered a scientific draughtsman unless he can apply perspective projection to the projection of shadows, the projections of the sphere, the constructions of maps and dials, and some other uses.
- For the second division of this course, in addition to what was before indicated, a competent knowledge of the theorems relating to the line and plane (Euclid, Book XI.) is essential.
- The following are some of the best works on the subject of Practical Geometry, but the list is not given as a complete one:—
- For Theoretical Geometry.—1. Geometry, Plane, Solid, and Spherical, &c. (Library of Useful Knowledge), published originally by Baldwin and Cradock, undoubtedly the best work on the subject.—2. Geometry, &c., by Mr. Bell, in Chambers's Educational Course, both comprehensive and excellent.—3. There are excellent elementary works based on Euclid in Gleig's School Series, and in that published by Messrs. Galbraith and Haughton in Ireland, also in Weale's Series, &c. &c.
- For Practical Geometry.—Bradley's Geometrical Drawing, published for the Committee of Council on Education by Messrs Chapman and Hall.—Bradley's Practical Geometry, Perspective and Projection (Library of Useful Knowledge).—Hall's Elements of Descriptive Geometry for Students in Engineering.—Heather's Descriptive Geometry for Students in Engineering in Weale's Series.—Also works by Winter, Burchett, and Binns.
- French works on this subject are numerous and excellent, by Lacroix, Lefebre de Fourcy, Leroy, Le Vallée, Adhemar, Bardin, &c. &c.

Subject II.—Machine Construction and Drawing

The application of the foregoing Subject I. to the drawing of machinery, in which great accuracy and neatness of drawing will be insisted on.

The candidate will be required to take measurements with calipers, &c., and to make drawings, elevations, and sections of a simple machine, or of parts of one, set before him. Also to draw a portion of a machine from written dimensions and description. He will be required to have sufficient knowledge of the principles of machine or portions of a machine from a rough sketch, applying the power to the greatest advantage, and obtaining such power or changes of motion as are required. In fine, such knowledge and readiness as would be required of a good draughtsman in an engineer's office.

Subject III.—Building Construction, or Naval Architecture and Drawing.

(See previous Subject.)

The candidate will be required to possess sufficient knowledge of construction—(1) to apply the various materials used in building to their greatest advantage; (2) to be able to make detail and working drawings showing a knowledge of the methods of construction and the framing of ordinary roofs, bridges, &c., whether of wood, iron, or masonry; (3) to frame estimates and take out quantities.

Neatness, accuracy, and facility in drawing will be insisted on, and the general requirements in this Subject will be such as would be possessed by a good draughtsman in an architect or builder's office, with a slight scientific knowledge for the proper application of the

materials he is required to work with.

N.B.—Naval Architecture may be taken instead of Building Construction; the same description of attainments will be required.

Subject IV.—Elementary Mathematics.

1. Arithmetic generally.

 Geometry.—The properties of lines, triangles, rectilinear figures, the circle; properties of similar figures; proportion of figures; inscribed and circumscribed polygons. The questions will have reference to Euclid's elements; but a sound knowledge of Geometry obtained

from any source will be accepted.

3. Algebra.—Definitions. Addition. Subtraction. Multiplication. Division. Greatest common measure. Least common multiple. Theory of indices (integral). Involution. Evolution. Simple equations, and problems producing them. Fractions. Quadratic equations, and problems producing them. Ratio. Proportion. Variation. Arithmetical, geometrical, and harmonical Progressions, Permutations, and Combinations. Binomial theorem for a positive integral index.

4. Plane Trigonometry.—Definitions. Conversion of degrees and their subdivisions into grades, and their subdivisions, and vice versa. Angular and circular measures of degrees and their relation. The goniometric functions of angles and the conversion of one into another. The arithmetical values of the goniometric functions of 90°, 45°, 60°, 30°, 180°, 120°, 150°, &c. The meaning of contrariety of signs in trigonometry. Tracing of the goniometric functions in magnitude and algebraic sign through the four quadrants and when an angle is indefinitely increased.

Formulæ for multiplication and division of angles, viz., sine, cosine, tangent, &c., of $(A \pm B)$, 2A, 3A, $\frac{A}{2}$, and $\frac{A}{3}$. Also of A and B in

terms of
$$\frac{A+B}{2}$$
 and $\frac{A-B}{2}$.

- Logarithms.—Definition. Multiplication, Division, Involution and Evolution by logs. The use of logarithmic tables. Tables of proportional parts for numbers and angles. Modulus. Construction of logarithmic tables, and of tables of logarithmic sines, cosines, &c.
- Triangles.—Formulæ for cosine of an angle of a triangle in terms of its sides. The relation between sines of angles and the opposite sides; sine, cosine, tangent, &c., of half an angle of a triangle in terms of sides, and of the sine of an angle. Area of a triangle. Solution of triangles. Diameters of circles inscribed in and circumscribed about a given triangle. Areas of regular polygons inscribed in and circumscribed about a given circle. Area of a circle. Description and use of vernier and theodolite and sextant (generally). Heights and distances of inaccessible objects.

For students to obtain a 5th class, a competent knowledge of the following alone will be required:—

(1.) Geometry. The first book of Euclid.

(2.) Algebra, to simple equations and problems (inclusive).

(3.) Plane trigonometry. The more elementary portions, including use of logarithms.

To obtain a 4th class:-

(1.) Geometry. The first three books of Euclid.

(2.) Algebra, to quadratic equations.

(3.) Plane trigonometry as far as solution of triangles, inclusive.

And for third, second, and first class Queen's prizes the remaining portion of the above subjects.

Subject V.—Higher Mathematics.

- Algebra.—Surds. Theory of indices (fractional and negative). Binomial theorem generally. Multinomial theorem. Exponential theorem. Indeterminate equations and problems. Indeterminate coefficients. Reversion of series. Properties of numbers.
- 2. Plane Trigonometry.—De Moivre's theorem and the expansion of sine, cosine, and tangent in terms of the angle.
- Spherical Trigonometry.—Definitions and fundamental propositions.

 Polar or supplemental triangle and its properties. Area of a spherical triangle. Spherical excess.

Fundamental formulæ expressing the relations of the sides and angles of a spherical triangle.

Napier's analogies.

Solution of right-angled spherical triangles and of oblique angled triangles.

- Mensuration.—Trapeziums. Regular plane rectilinear figures. Irregular plane curvilinear figures (Simpson's or Stirling's Rules). Volumes and surfaces of Parallelopipeds, Pyramids, Cylinders, Cones, and Spheres.
- Differential and Integral Calculus.—Definitions. Differential of elementary functions, including circular and logarithmic functions. Vanishing fractions. Maxima and minima of one independent variable. Tangents and normals of curves. Differential coefficients of Areas, Arcs, Volumes and surfaces of solids of revolution.
 - Integration of elementary functions. Integration by parts. Rational fractions. Integration between limits. Areas and lengths of simple curves. Volumes and surfaces of solids of revolution.

Subject VI.—Mechanics as a Science, or Theoretical Mechanics.

Statics. Composition and resolution of forces. Forces acting on a point—on a rigid body. Parallel forces. Centre of gravity. Theory of moments or couples. Principle of virtual velocities. The mechanical powers. Friction. Equilibrium of roofs and arches.

Dynamics. Laws of motion. Uniformly accelerated motion. Motion by gravity Variable forces. Projectiles. Centrifugal force. Motion on inclined planes—on curves. Pendulums. Motion of rigid bodies, free or constrained. Moment of Inertia. Centre of oscillation—of percussion. Motion of flexible bodies, such as a musical string.

Hydrostatics, Hydrodynamics, and Pneumatics. Mechanical properties of liquids. Law of pressure. Centre of pressure. Laws of floating bodies. Capillary attraction. Laws of fluid motion, through open

channels, closed pipes, or orifices.

Mechanical properties of elastic fluids. Theory of barometers. Connexion between pressure, temperature, and volume. Specific heat. Weight of atmosphere. Use of barometer in calculating heights.

In this subject the candidate will have to show a mathematical knowledge of the laws of Mechanics, and must be able to prove from

first principles the principal theorems.

The books recommended for study are—Whewell's Elements of Mechanics, or Snowball's; Moseley's Engineering Architecture; Natural Philosophy, by Dr. Golding Bird and Mr. Brooke; Goodwin's Elementary Course.

Subject VII.-Mechanics as an Art, or Applied Mechanics.

General principles of mechanism. Elementary combinations. When the connexion is by rolling contact, sliding contact, wrapping connectors or linkwork, with constant or varying velocity ratio, and constant or

varying directional relation.

Machines of ordinary occurrence must be thoroughly understood and particular parts to be described and drawn: such as cranes; lathes; drills: planing, punching, boring, shaping, and slotting machines. Spinning and weaving machinery. Mode of calculating power of machinery. Dynamometers, indicators, &c.

Materials. The general properties of materials. Elasticity. Weight. Specific weight. Mechanical work. Work done by pressure, by impact, by expansion of elastic gases and steam, by animal muscular

effort.

Resistance to expansion, to compression, to rupture. Friction of solids. Its importance in construction. Resistance of fluids to bodies moving within them. Adaptation of form and material for maximum resistance. Beams of greatest strength. Construction of roofs, arches, stone and timber bridges, suspension bridges, and tubular girders.

Hydrostatics, Hydrodynamics, and Pneumatics. Pressure on floodgates; locks; water-wheels; turbines; water-pressure engines; breakwaters. Hydrometers. The syphon. Hydraulic ram. Pumps. Diving bell. Condenser. Windmills. Steam-engines, stationary, marine, locomotive. The steam hammer. Water supply to towns.

Theory of tides, in the open sea, and in rivers.

In this subject the candidate will be expected to show how the principles are applied in actual practice: he will be expected to show by clear well-drawn sketches, his acquaintance with parts of machines.

The candidate will have tools and models put before him, with some of which he must show he is familiar, and that he can explain their use and construction.

Books recommended:—Willis's Mechanism; Baker's Elements of Mechanism; the books in Weale's Series which treat on the subjects specified. Twisden's Practical Mechanics; Goodeve's Elements of Mechanism.

Subject VIII .-- Acoustics, Light, and Heat.

Acoustics.

The candidate ought to know the manner in which sound originates, and is propagated; its velocity in different media, and how its velocity

through air is affected by density and temperature.

He ought to know the origin of musical sounds; of pitch; of harmony and discord; to commit to memory the rates of vibration of the several notes of the gamut; to be able to make sonorous vibrations visible by means of glass plates and membranes; to calculate the length of sonorous waves, and to determine practically the number of vibrations due to any particular note. He ought therefore to understand the construction and use of the Syren.

He ought to be able to describe and illustrate the condition of a vibrating string, or column of air at its nodal points and ventral segments and

to explain echos and resonance.

Light.

The candidate ought to know how its velocity was first determined from

observations upon Jupiter's satellites.

He ought to be able to devise a simple means of exhibiting both the reflection and refraction of light; to be able to state the laws of both; to explain what is meant by total reflection; and to apply it to the explanation of the Mirage of the Desert, the Phantom Ship, and other similar phenomena.

He ought to be able to explain why the image in a plane mirror must appear as far behind the mirror as the object is in front of it; why a stick appears bent when dipped obliquely into water; and why the bottom of a river or lake, or of a basin which holds water, appears to

be nearer to the surface than it really is.

He ought to be able to determine the positions of the foci of spherical mirrors, both concave and convex; to describe the characters of their images, whether erect or inverted; magnified or reduced; and to do the same for convergent and divergent lenses.

He ought to know the construction of the human eye: the conditions of distinct vision, the use of spectacles; and to be able to describe a simple form of the reflecting and refracting telescope and of the

microscope.

He ought to know the constitution of light; to be able to describe the spectrum produced by refraction with a prism; to explain the origin of colours, and to give a clear explanation of the rainbow.

Heat.

The candidate ought to be able to describe the construction and graduation of an ordinary mercurial thermometer; to understand the scales of Fahrenheit, Celsius, and Reaumur.

He ought to have clear ideas of conduction and radiation; to be able to devise some simple means whereby the conductive and radiative powers of different bodies may be determined; to explain fully the formation of dew, and to state the conditions favourable to its production.

He ought to know the effect of heat upon the volumes of bodies; to know what is meant by the coefficient of expansion, and how it may be determined; to give illustrations of the enormous power of heat in

producing expansion; to state exceptional cases; to know the manner in which heat is propagated through liquids and gases, as distinguished from ordinary conduction; and to be able to combine two metals possessing different coefficients of expansion, so as to form a compensating pendulum.

He ought to know the meaning of latent heat and of specific heat, and to illustrate both by reference to ice, water, and steam; he ought to be able to show the influence of the high specific heat of water upon

an island climate.

He ought to know the strict physical meaning of ebullition; and the influence of pressure upon the boiling points of liquids; he ought to have a general knowledge of the origin of winds and clouds, and to be able to explain the fact that the rain-fall upon the south-west side of a mountain chain in England and Ireland is much more copious than on the north-east side.

Text Books:—See next subject.

Subject IX -Magnetism and Electricity.

Magnetism.

The candidate ought to know the action of one loadstone upon another which is freely suspended, or set afloat upon a liquid; he must have a perfectly clear notion of magnetic polarity, and of the action of magnetic poles upon each other.

He must know the difference between the action of magnetised and unmagnetised steel upon a magnetic needle; also the difference between soft iron and hard steel, with regard to their acceptance and retention of the magnetic condition; (coercive force).

He must be able clearly to state the condition of a mass of soft iron when under the influence of a magnet, and in virtue of which condition the iron is attracted; (magnetic induction).

He must be able to describe the action of the earth upon a magnetic needle; must know the meaning of declination, inclination or dip, and of secular and diurnal variation; the action of the earth upon a bar of soft iron according as it is held in the direction of the dip or at right angles to this direction; finally, the effect of percussion in rendering the condition assumed by the bar of soft iron a permanent one.

He ought to be able to compare accurately the strength of one magnet with that of another, and to state how the relative intensity of the earth's magnetism at two points of its surface may be ascertained.

Frictional Electricity.

The candidate ought to know various simple ways of exciting electricity to be clearly informed as to the duplex character of the force; to know the condition of the rubber as well as that of the body rubbed; and to be conversant with various forms of electroscopes and electrometers.

He ought to know the foundation of the terms vitreous and resinous, positive and negative; to be able to illustrate the action of two electrified bodies upon each other; and to tell at once whether a body is positively or negatively charged.

He ought to have a clear knowledge of electric conduction, insulation, and induction; and be able to explain the state of a neutral conductor when acted upon by an electrified body; he ought to be able to prove, experimentally, that though we cannot by breaking a magnet obtain two halves each with a single pole, we can by breaking an electrified body obtain two halves each charged with a single electricity.

- He ought to be able to explain the influence of points and flames when attached to an electrified conductor; and to describe the action of lightning conductors.
- He ought to be able to describe the electric machine, and the electrophorus; and to explain the action of the condenser and of the Leyden jar.
- He ought to be able to state the principal effects of the electric discharge; to state the atmospheric conditions necessary to the production of a thunderstorm; and to give a clear account of the so-called return stroke.

Voltaic Electricity.

- The candidate ought to be able to state precisely how voltaic electricity may be generated; to describe Volta's pile, and his crown of cups; and also the batteries of Daniell, Grove, and Bunsen.
- He must have a clear conception of what is meant by the direction of an electric current; and be able to illustrate in the fullest manner the action of a current upon a freely suspended magnetic needle. Given the direction of the current, he must be able to state how the needle moves; given the movement of the needle, he must be able to infer from it the direction of the current.
- He must be able to describe fully the action of a current upon soft iron; and to infer from the direction of the current the nature and position of the magnetic poles, which it excites.
- He must be well acquainted with the chemical reactions which take place both in the batteries, mentioned above, and also in other liquids through which the current may be sent.
- He must be able to measure the strength of an electric current, and he is strongly recommended to master thoroughly the law of Ohm, regarding the mutual relations of electromotive force, resistance, and strength of current.
- He ought to be acquainted with the so-called polarisation of metallic plates between which a current passes through a liquid, and to show how this is avoided in Grove's battery.
- He ought to be able to give a clear description of some one form of the electric telegraph.
- He ought to be acquainted with the physiological effects, and with those of light and heat produced by the voltaic current; and to show the dependence of the heat on the strength of the current, and on the resistance which it encounters.
- It would also be well to master as much of the phenomena of induced currents as would enable the candidate to explain the action of the galvanizing apparatus used by medical men.
 - Note.—The candidate will perceive that this list is long because the objects to which he is to devote his attention are separately specified. Definition is thus given to his studies and their precise scope marked out for him. He is recommended to repeat with his own hands, as far as it is in his power to do so, the experiments which he finds described in good handbooks of Natural Philosophy; this will give a certainty to his knowledge and an interest to his pursuits which mere reading can never confer. The first requisite demanded of him on his examination will be that, however small his knowledge, it shall be well digested and sound.

Text-Books:—Lardner's Handbook of Natural Philosophy; Natural Philosophy, by Dr. Golding Bird and Mr. Brooke.

Subject X.-Inorganic Chemistry.

The general principles of chemical philosophy. Laws of combination. Volume weights. Combining weights. Atoms and molecules. Chemical symbols and their use in the explanation of chemical changes. Quantivalence.

The non-metallic elements:

Hydrogen. Water. Chemical composition and properties. Adaptation for domestic purposes. Hardness, permanent and temporary.

Oxygen. Combustion.

Sulphur. Sulphuretted hydrogen. Sulphurous acid, sulphuric acid, hyposulphurous acid, hyposulphuric acid. Manufacture of oil of vitriol. Bisulphide of carbon.

Chlorine. Hydrochloric acid. Hypochlorous acid. Bleaching agents and theory of bleaching. Chloric acid and perchloric acid. Chloride of nitrogen. Chlorides of carbon.

Bromine. Hydrobromic acid and bromic acid.

Iodine. Hydriodic acid. Iodic acid, periodic acid.

Fluorine. Hydrofluoric acid.

Nitrogen. Ammonia. The oxides of nitrogen.

Phosphorus. Phosphoretted hydrogen. Hypophosphorous acid, phosphorous acid. The several modifications of phosphoric acid: ordinary phosphoric, pyrophosphoric, and metaphosphoric acids. Theory of polybasic acids. Chlorides of phosphorus. Manufacture of matches. Carbon. Marsh gas. Carbonic oxide. Carbonic acid. Olefiant gas.

Carbon. Marsh gas. Carbonic oxide. Carbonic acid. Olefiant gas.

Manufacture of coal gas. Nature of flame.

Silicium. Silicietted hydrogen and silicic acid. Hydrofluosilicic acid. Boron and boracic acid.

The metals: Potassium. Manufacture of nitre. Manufacture of gunpowder. Theory of the action of gunpowder. Sodium. Manufacture of soda.

Barium. Strontium. Calcium. Mortars.

Spectrum analysis; its principles and applications.

Magnesium, Aluminium. Manufacture of glass and porcelain.

Manganese. Iron. Composition and properties of cast iron, wrought iron, and steel.

Cobalt. Nickel. Chromium. Zinc. Cadmium. Copper. Lead. Manufacture of white lead.

Bismuth. Mercury. Tin. Arsenic. Course of analysis in cases of poisoning.

Antimony. Silver. Gold, and platinum. Principal compounds of the metals with the non-metallic elements.

Outline of qualitative analysis. Reactions of the principal mineral acids and bases. Course pursued in the application of these reactions to the analysis of a mixture of several acids and bases.

The following is the list of Apparatus and Re-agents with which Candidates make their analysis at the examination:—

APPARATUS.

Test tubes and stand.

Metal filter stand.

Wash bottle containing distilled water.

Spirit lamp.

Black blowpipe.

Charcoal for blowpipe experiments.

Iron spoon.
Tongs.
Pestle and mortar.
Porcelain dishes.
Watch glasses.
Porcelain crucible.
Triangles.
Test tube cleaner.

Platinum wire and foil. Funnels.
Cut filters.
Sulphuretted hydrogen apparatus.
Platinum crucible.
Herapath's blowpipe,
Stirring rods.

RE-AGENTS. In the liquid state.

Sulphuric acid.
Hydrochloric acid.
Nitric acid.
Hydrosulphuric acid.
Potassa.
Ammonia.
Ammonium, chloride.
Ammonium, carbonate.
Ammonium, molybdate.

Ammonium, oxalate. Sodium, phosphate. Barium, chloride. Calcium, chloride. Lime water. Calcium, sulphate. Potassium, sulphate. Potassium, sulphate. Potassium, chromate. Oxalic acid. Tartaric acid.

Acetic acid.
Hydrofluosilicic acid.
Lead, acetate.
Iron, sesquichloride.
Potassium, ferrocyanide.
Potassium, sulphocyanide.
Platinum, chloride.
Silver, nitrate.

In the solid state.

Sodium, carbonate. Potassium, nitrate. Potassium, cyanide. | Borax. | Lime. | Iron, sulphate. Blue and red litmus paper.

Subject XI.—Organic Chemistry.

Definition of organic bodies. Their ultimate analysis. Calculation of an empirical formula. Methods of controlling an empirical formula. Determination of the molecular weights of organic acids and bases. Determination of the vapour-density of volatile bodies. Law of substitution. Synthesis of organic compounds.

The chemical history of the Cyanogen group. Cyanogen. Hydrocyanic acid. Cyanic acid and urea. Fulminates. Cyanuric acid. Sulpho-

cyanic acid. Chlorides of cyanogen.

Amylaceous and saccharine substances. Fermentation. Alcohol, and its homologues. Ethers, simple and mixed. Oxidation of alcohol, Aldehyde and acetic acid, and their homologues. Chloride of acetyl. Anhydrides, simple and mixed. Compound ethers. Diatomic alcohols and their acids. Glycol and oxalic acid. Triatomic alcohols. Glycerine. Fatty and oily bodies.

Tartaric and citric acids. Tannic acid.

Aromatic bodies. Benzoic alcohol, aldehyde, and acid; their derivatives, their homologues. Salicylous and salicylic acid. Gallic and cinnamic acid. Hippuric acid.

Ammonia and its derivatives. Amides and amines: their classification.

Examples of natural alkaloids.

Principal colouring matters. Indigo and its derivatives. Examples of products formed by destructive distillation. Colours derived from coal tar. The chief constituents of the vegetable and animal organism, fibrin, albumen, casein, &c.

The chemical principles of agriculture.

The chemical principles of the process of nutrition and respiration in

the animal organism.

Text-books. — Graham's Elements of Chemistry, Miller's Elements of Chemistry, Fownes' Manual of Chemistry, Bloxam's Chemistry, Inorganic and Organic, Galloway's First and Second Steps in Chemistry, Williamson's Chemistry for Students, Frankland's Lecture Notes, Roscoe's Lessons in Elementary Chemistry.

Subject XII. —Geology.

General Principles.

 The division of rocks into three great classes, aqueous, igneous, and metamorphic.

The mode of formation of stratified rocks, such as ordinary marine strata of shales, sandstones, conglomerates and limestones —delta formations—freshwater and terrestrial beds, and the signs by which you can distinguish these, such as the nature and mode of the occurrence of the genera of animals and plants that are found in them.

3. The theories of central heat, and of the consolidation of the earth

from a state of igneous fusion.

4. The mode of occurrence of igneous rocks, intrusive bosses, lavas, volcanic ashes, and dykes.

5. Volcanoes and volcanic phenomena; the origin of volcanoes and the

cause of eruptions.

 Elevation and depression of land; the distribution and origin of mountain chains. Denudation of the earth's surface, origin of release.

valleys, &c.

7. The ordinary mineral substances that enter into the composition of rocks, such as granites, diorites, basalts, &c. Gneissic rocks, sandstones, slates, shales, clays, &c. The origin of limestones. The origin of mineral veins or lodes.

8. Fossilization of organic bodies.

9. Table of geological formations, including those larger divisions absent in Britain.

10. Theory of metamorphism of rocks. Origin of cleavage.

11. Explanation of geological terms.

 Definition of zoological terms used in geology, such as genus, species, bivalve and univalve shells, cephalopod, brachiopod, palæozoic, &c. &c.

13. The meaning of breaks in the succession of life (changes of genera

and species) in the different formations.

Stratified Formations, &c.

1. Description of the Cambrian and Silurian strata, their physical characters, fossils, and any unconformities that exist in the British Silurian strata.

Description of the Old red sandstone and Devonian rocks, characters and fossils. Slate and slate quarries, building-stones, limestones,

and marbles of these and the Silurian formations.

3. The Carboniferous limestone and Coal-measure series. Character, fossils, and mode of formation. Nature of the plants of the Coal-measure epoch. Their mode of growth. Origin of coal, its mode of occurrence, and how the vegetable matter became changed into coal. Mode of occurrence of the ironstone of the Coal-measures. Various kinds of coal, and the relation of anthracite coal to disturbance of strata. Limestone quarries, marbles, and building-stones. Clay pits and potteries of the Carboniferous strata. Fire clay. Alum shale, &c.

4. The Permian rocks. Their stratigraphical relations to the underlying strata, composition of rocks, fossils, and building-stones. Great break in the succession of life between the Palæozoic and Mesozoic

or secondary strata.

The New red sandstone (or Trias), its subdivisions, fossils, buildingstones, sand pits. Origin of rock salt and brine springs.

 The Rhetic beds and Lias, their subdivisions, fossils, building-stones and hydraulic limestones, and clay pits.

 Oolitic rocks. Subdivisions, leading marine and land fossils. Limestones, clay pits, coal, jet and other economic products.

8. The Purbeck and Wealden strata. Origin, subdivisions, chief fossils, building-stones, and marbles. Ironstones and limestones. Clays. Great break in the succession of marine fossils between the Oolitic and Cretaceous strata.

Cretaceous rocks. Subdivisions, lithological characters, fossils, building stones of Lower Greensand. Gault, its phosphatic nodules and general uses. Upper greensand, chalk, &c. Building stones. Origin and uses of chalk-flints. Great break in the succession of marine fossils between cretaceous and eocene strata.

10. Eccene, or older Tertiary beds. Subdivisions, alternation of marine and freshwater beds, chief fossils, limestones and building stones,

clays for bricks and potteries.

11. Miocene or middle tertiary strata, marine and freshwater, fossils. &c.

12. Crag. Its subdivisions, chief fossils. Origin of its phosphatic remains.

13. The glacial period, boulderclay, and evidence of old glaciers in Britain, River gravels, &c. of post-tertiary age, and their contents.

14. Disturbance and denudation of strata in successive periods, &c.

15. Unconformities, faults, and fractures.

16. The causes of gaps in the succession of strata, or of breaks in the succession of life in time.

17. Water-bearing strata, and underground drainage. Artesian and

other wells.

18. British rocks in which ores of metal are found, and the general mode of occurrence of these ores in beds of solid rock, in superficial detritus and in lodes.

19. The rules that ought to guide the miner in sinking for coal and other minerals, when the beds in which they lie are concealed by

over-lying and unconformable strata.

Text-books.—Lyell's Principles of Geology; Lyell's Elements of Geology; Phillips' Manual of Geology; Jukes' Manual of Geology; Juke's Geology for Schools; Page's Introductory Text-Book; Page's Advanced Text-Book; Ramsay's Physical Geology and Geography of Great Britain; Woodward's Recent and Fossil Genera of Shells.

Subject XIII .- Mineralogy.

A. Instruction in this subject should commence with a distinct understanding of the characters by which minerals, properly so called, are to be distinguished from other inorganic substances, and of the position of this science in relation to the collateral sciences of

physics, chemistry, and geology.

B. Crystallography, as the essential means of appreciating the forms naturally assumed by almost all inorganic bodies, must commence with the needful geometrical definitions, proceed to the grouping of the various crystalline forms into systems, consider the laws by which the derivation of one form from another within the limits of the same system is determined, and explain the combination of various simple forms in the faces exhibited by compound crystals. It is also important to study the deviations from regularity which are commonly presented in nature, and the methods of measuring those elements which remain constant.

c. The various kinds of aggregation exhibited by crystalline substances are also to be considered, especially with reference to masses of the

useful minerals, and of crystalline rocks.

D. Next in order will follow the other physical characters of minerals: 1st. in relation to their substance, as cleavage, fracture, hardness, and specific gravity: 2ndly, in relation to the effects of light, as transparency, refraction, lustre, and colour; 3rdly, as to their electric and magnetic properties.

E. The chemical characters of minerals, and the most convenient modes of testing them; 1st, by aid of the blowpipe; 2ndly, by the

F. Pseudomorphism, or the remarkable phenomena presented by minerals which have the composition of one mineral coupled with the form of another.

G. The physiography or systematic description of minerals. This last division should include all the more remarkable varieties as well as species, and should take especial note of the modes and places of occurrence, as well as of the association of particular groups of minerals in certain veins or formations.

As text-books may be recommended-

Professor Ansted's Elementary Course of Mineralogy and Geology. London, 1856.

Nicol's Elements of Mineralogy. Edinburgh, 1858.

Dana's Manual of Mineralogy, 1851.

Bristow's Dictionary of Minerals. Longman & Co. 1861.

For more advanced students-

Brooke and Miller's Mineralogy. London, Longman, 1852.

On Crystallography. Rev. W. Mitchell, in Orr's "Circle of the Sciences." London, 1856.

Dana's System of Mineralogy. 4th edition. Putnam, 1854.

Naumann's Mineralogie. Leipzig. Williams and Norgate, London.

Breithaupt's Paragenesis der Mineralien. Freiberg, 1849. Haidinger's Handbuch der Mineralogie. Vienna, 1845.

When it is intended to teach this subject with special reference to the practical working of minerals, the physiographical part will be occupied more particularly with certain of the useful species and their associated substances, and the following works may be consulted:—

W. J. Henwood on the Metalliferous Deposits of Cornwall and Devon,

1843.

Bischof, Chemical and Physical Geology, translated by the Cavendish Society. 1854.

Subject XIV.—Animal Physiology.

Candidates must be prepared to answer questions upon the following points in Human Anatomy and Physiology:—

The plan of the human body and the arrangement of its parts.

The meaning of the terms organ and tissue.

The general structure and disposition of the principal organs and tissues.

The ultimate chemical composition of air, water, carbonic acid, urea; of protein, fat, starch, and augar; of bone-earth and horn.

The meaning of the term function.

The general working of the body considered as an engine; its waste, and the mode in which that waste is made good.

The particular functions of the different organs.

The structure and working of the heart and blood vessels.

The nature of the lymphatics and lacteals.

The course of the circulation of the blood, and the evidence that it circulates.

The pulse and the sounds of the heart.

The regulation of the circulation by the nervous system.

The structure and properties of blood corpuscles.

The process of the coagulation of the blood.

The proximate chemical constituents of the blood, and the uses of that fluid.

The difference between arterial and venous blood. The way in which that difference is brought about. The working of the chest and lungs in respiration.

The difference in chemical composition between inspired and expired air. The daily loss of carbon and gain of oxygen. Stationary and tidal air.

The respiratory murmurs. The nature of asphyxia, and the

necessity for fresh air.

The structure and uses of the kidneys. The daily loss of nitrogen in the shape of urea, of uric acid and of saline matters, by the kidneys.

The structure and uses of the skin.

The relations of the lungs, skin, and kidneys.

The structure and uses of the liver. The nature of the bile.

The development, distribution, and regulation of the heat of the body.

The composition of aliments: proteids, fats, amyloids, and minerals.

Essential and accessory alimentary substances. Economy of a mixed diet.

The digestion and absorption of aliments.

Cilia and muscles; their structure and properties. The levers of the body. The structure of joints. Locomotion.

The structure and working of the larynx. Voice and speech.

The muscular sense. The organs of the higher senses, touch, taste, smell, hearing, and sight, and the manner in which they intermediate between the cause of the sensation and the expansion of the nerve. The adjustment of the eye to distances. The theory of the stereoscope.

Simple and compound sensations.

Auditory and ocular spectra. Auditory and optical delusions.

The general structure of the nervous system. The properties

The general structure of the nervous system. The properties of nerves, and of the spinal cord, brain, and sympathethic. Vasomoter nerves.

Reflex actions, natural and acquired.

Text-books for Physiology.—Carpenter's Animal Physiology; Kirke's Manual; Huxley's Lessons in Elementary Physiology.

Subject XV.—Zoology.

 Candidates should have carefully mastered the definitions of the sub-kingdoms, classes, and orders of the Animal Kingdom. They should understand and be able to explain the meaning of the terms employed in such definitions; and they should be able to refer any specimens that may be placed before them to their proper classes.

2. Candidates should be prepared to give fair answers to questions relating to any or all of the following subjects, and they should be able to identify, refer to their proper orders, and if called upon to do so, describe, the objects enumerated in each section under the head of "types." In almost all cases these "types" are British animals.

By the term Natural History, of such and such an object, is meant such an account of it as is to be found in any standard modern work on Zoology.

i. The structure and mode of multiplication of infusorial animalcules and Foraminifera. The arguments which have been adduced for and against spontaneous generation. The luminosity of the sea, and the nature of the creatures which chiefly cause it. The natural history of the sponge of commerce. Types—Spongia, Vorticella.

ii. The meaning of the terms, zoophyte, coral, coralline. Natural history of the red coral of commerce. Common coral and coral reefs. What such reefs are, where they are formed, and how they grow. Natural history of the common freshwater polype, or hydra, and of the "jelly fishes," or "medusæ" of the sea. Asexual multiplication as exhibited by these creatures. Types—Hydra, Sertularia, Plumularia, Actinia, Corallium, Fungia, Oculina.

iii. Starfishes, sea urchins, and Holothuriæ; their structure and habits, and the metamorphoses which they undergo. Natural and

economical history of Trepang. Types-Uraster, Echinus.

iv. Natural history of the earthworm and the leech. Intestinal worms; their structure, propagation, and mode of entrance into animal bodies. Natural history of the Rotifera. Types—Lumbricus, Hirudo, Distoma, Tania, Ascaris.

v. Natural history of Crustacea. The lobster and crayfish, as exemplifying morphological and teleological laws. The process of ecdysis. Barnacles, acorn shells, and fish lice, as cases of extreme metamorphosis. The water flea as exemplifying asexual multiplication. Types—Cancer, Homarus, Astacus, Oniscus, Daphnia, Cyclops, Lepas, Balanus, Argulus.

vi. Natural history of spiders, scorpions, and mites. The "itch insect." centipedes, and millipedes. Types—Tegenaria, Scorpio,

Scolopendra, Julus.

vii. Insects; their mode of breathing as contrasted with that of spiders and crustaceans. The structure of their wings, and the mechanism of flight. The parts of the mouth and their modifications in beetles, bees, butterflies, bugs, and gnats. Structure of the eyes. Nature of stings, saws, and ovipositors. Natural and economic history of the blistering beetle, of the silk moth, of the bee, of the cochineal insect. Natural history of plant lice, of bugs, fleas, and lice. The house fly, blow fly, and gnat; wasps, humble bee, ichneumon flies; "black beetles," crickets, and locusts. The metamorphoses of insects. Types—Melolontha, Blatta, Libellula, Phryganea, Coccus, Aphis, Bombyx, Apis, Vespa, Musca.

viii. The characteristic peculiarities of the nervous, circulatory, respiratory, and locomotive organs of mollusks in general. Organization of "sea mat" (Flustra). Ascidians and "lamp shells" (Terebratula). Natural history of fresh-water and marine mussels. Nature of mother of pearl. Formation of pearls. Pearl fishery. Natural and economical history of the oyster. Organization of snails and slugs, periwinkles, limpets, whelks. Development of the young of the latter. Nidamental capsules. Cuttlefishes and squids. Paper nautilus. Pearly nautilus. The shipworm and Pholas. Mechanism by which mollusks bore. Types—Flustra, Ascidia, Terebratula, Unio, Mytilus, Ostrea, Pecten, Helix, Patella, Littorina, Buccinum, Chiton, Sepia, Loligo, Argonauta, Nautilus.

- ix. Circulatory, respiratory, and reproductive organs of fishes. Their dentition. Natural and economical history of the lamprey, sprat, sardine, herring, pilchard, salmon, trout, eel, cod, haddock, sole, flounder, turbot, mackerel, tunny, sturgeon, skate, ray, dog fish, shark. Electrical fishes. Fishes which are capable of living in air. Pisciculture, or the artificial breeding of fishes. Types—Amphioxus, Petromyzon, Syngnathus, Cyprinus, Perca, Accipenser, Lepidosteus, Raia, Spinax.
- x. Natural history of salamanders, newts, frogs, and toads, Metamorphoses undergone by their young. Types—Salamandra, Triton, Rana.
- xi. Circulatory and respiratory organs of reptiles as distinguished from those of fishes and amphibia. Natural history of snakes, lizards, crocodiles, turtles, and tortoises. Tortoise-shell. Shedding of the skin in reptiles. Types—Coluber, Pelias, Anguis, Lacerta, Crocodilus, Testudo, Chelone.
- xii. Organs of locomotion, respiration, voice, circulation, and reproduction of birds. Structure and mode of growth of feathers Development of the fowl's egg. Artificial hatching, Migration,

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and instincts of birds. Natural history of domestic birds; of the ostrich, the apteryx, the penguin, and the dodo. Types—Falco,

Corvus, Columba, Picus, Phasianus, Ardea, Struthio, Anser.

xiii. Organs of respiration, circulation, and reproduction of mammals. Production and nutrition of their young. Placental and implacental mammals. Nature of milk and of the lacteal glands. Peculiarities in the dentition of mammals. Natural and economic history of the domestic mammals; of the ivory and fur yielding mammals; of seals; of whales. The hybernation and migration of mammals. Characters of the orders of mammals. Types—Cercopithecus, Vespertilio, Erinaceus, Lepus, Elephas, Sus, Cerus, Bos, Ovis, Felis, Phoca, Phocæna, Dasypus, Halmaturus, Ornithorhynchus.

xiv. The distinctive peculiarities of man. The characters of the principal races of mankind, and their geographical distribution.

Text-books for Zoology.—Dallas's Natural History of Animals in Orr's Circle of the Sciences; Gosse's Manual of Marine Zoology; Professor Greene's Manual of the Protozoa; Rymer Jones's Animal Kingdom.

Subject XVI.—Vegetable Physiology and Economic Botany.

In this department the candidate will be expected to answer correctly questions on the following points:—

 The properties of the principal elements entering into the composition of plants. Carbon, oxygen, hydrogen, nitrogen, sulphur, phosphorus, chlorine, iodine, silicon, potassium, sodium, calcium, iron.

2. The composition and properties of the compounds forming the principal part of the structure of plants. Cellulose, starch, dextrine, sugar, fixed oil, gluten, albumen, caseine. The saline compounds forming the ashes of plants.

3. The composition and properties of peculiar vegetable products. Volatile oils. Acids. Colouring matters. Alkaloids. Neutral principles. Chlorophyll.

4. The origin and growth of the vegetable cell. The tissues of plants Cellular tissue. Intercellular organs. Epidermal tissue. Hairs

Stomates. Vascular tissue. Woody tissue.

- 5. The structure and functions of the organs of plants. The root. Spongioles. Absorption and excretion. Nature of vegetable food. The stem. Structure of Exogenous, Endogenous, and Acrogenous stems. The leaf. The forms of leaves. Exhalation. Stipules and bracts. The flower. Calycine, Corollal, Staminal, and Carpellary leaves. Development and nature of pollen. Ovules or seed buds. Vegetable impregnation. Embryo. Seed. Fruits; their nature and forms. The nature of the reproductive organs in flowerless plants.
- 6. The composition and nature of vegetable substances used by man as food. Distinctions between heat-giving and flesh-forming foods. Structure and geographical distribution of plants yielding starch, sugar, oil, gluten, albumen, and legumin.
- Properties of vegetable substances used in the arts and manufactures.
 Vegetable secretions used as dyes.—Indigo, madder, logwood, red sanders wood, quercitron, alkanet, arnotto, gall-nuts, myrobolans.
- 8. Materials used in the manufacture of textile fabrics.—Cotton, flax, hemp, coco.nut, jute, New Zealand flax.
- Principal forms of timber trees, and their uses.—Oak, mahogany, teak, pine, &c.
- Nature of tanning principles and plants yielding tannic acid.—Oakbark, valonia, catechu, kino, divi-divi, betel-nut.

11. Gums, oils, and resins used in arts.—Gum arabic, benzoin, rosin, turpentine, camphor, essential oils, coco-nut oil, palm oil, other

fixed oils, caoutchouc, gutta pertsha.

12. Substances obtained from the vegetable kingdom and used as medicines.—Opium, quinine, tobacco, jalap, scammony, gentian, aloes, rhubarb, senna, ipecacuanha, sarsaparilla, castor-oil, assafcetida, myrrh, nux vomica, hemlock.

Text-books for Vegetable Physiology and Economic Botany.—Henfrey's Elementary Course of Botany; Van Voorst. Carpenter's Vegetable Physiology, edited by Dr. Lankester; Bohn. Schleiden's Principles of Scientific Botany; Bohn. A Manual of Structural Botany by M. C. Cooke. Archer's Popular Economic Botany; Reeve and Co. Lindley's Medical and Œconomical Botany; Bradbury and Evans.

Subject XVII.—Systematic Botany.

In this department the candidate will be expected to demonstrate the

structure of plants from living specimens.

1. The distinctions between the three great classes of plants, Dicotyledons, Monocotyledons, and Acotyledons. Also of the groups Gymnosperms, Rhizanths, Dictyogens, Acrogens, and Thallogens.

2. The characters of the following orders of British plants should be mastered, and the typical genera recognized, and their structure

understood.

3. Algæ. The natural history and uses of sea-weeds. The microscopic structure of diatoms and desmids. Nature of the reproductive organs in this order. Types-Navicula, Desmidium, Conferva, Fucus. Ceramium.

4. Lichens. The natural history and uses of lichens. Structure of their

reproductive organs. Types—Graphis, Collema, Parmelia.

5. Fungi. The natural history of mushrooms, puff-balls, moulds, blights, and toadstools. Their uses in nature. Types—Agaricus, Bovista, Torula, Aspergillus, Morchella, Mucor.

6. Mosses. The nature of their reproductive organs. Types - Bryum,

Sphagnum, Funaria.

7. Ferns. Nature of their rhizomes. Herbaceous and tree ferns. History of Development, and nature of reproductive organs. Types

-Polypodium, Hymenophyllum, Osmunda.

8. Graminaceæ. The history of grasses and their uses. Nature of the flower in this order. Useful plants of the order. Types—Phleum, Hydrochloa, Panicum, Agrostis, Arundo, Spartina, Avena, Festuca, Hordeum, Triticum, Secale, Nardus, Anatherum.

9. Cyperaceæ. Sedges. Types—Carex, Scirpus.

The lily tribe, its useful properties. 10. Liliaceæ. Types—Tulipa, Ornithogalum, Muscari.

11. Amaryllidaceæ. The family of the narcissus, snow-drop, snow-flake.

Types—Narcissus, Galanthus.

12. Orchidaceæ. The orchis family. Structure of reproductive organs.

Types—Orchis, Goodyera, Malaxis, Cypripedium.

13. Amentaceæ. The family of the hazel, chestnut, oak, willow, birch, beech, poplar, and hornbeam. The uses of these plants as timber. &c. Types-Quercus, Corylus, Fagus, Castanea, Betula, Myrica, Salix, Populus.

14. Urticaceæ. The nettle and hop tribe. Its relations to Moraceæ, Artocarpacæ, Cannabinaceæ, and Ulmaceæ. The nature of the stings of Urtica, and the bitter principle of the hop. Types-Urtica,

Parietaria, Humulus.

15. Euphorbiaceæ. The spurge family. Foreign forms and their uses. Croton, Cascarilla, Ricinus, Janipha. Apetalous and Polypetalous forms. Types—Euphorbia, Buxus.

16. Polygonaceæ. The buckwheat and rhubarb tribe. Types—Polygonum, Rumex.

Primulaceæ. The primrose family. Theory of the peculiar position of stamens. Types—Primula, Lysimachia.

18. Labiatæ. The dead nettle tribe. Peculiar properties of this order Types-Mentha, Salvia, Thymus, Nepeta, Lamium, Teucrium.

19. Scrophulariaceæ. The scrophularia tribe. Nature of the poisonous properties of the order. Types-Scrophularia, Digitalis, Verbascum, Euphrasia, Veronica, Melampyrum.

20. Boraginaceæ. The borage tribe. Peculiarities of their epidermis. Types-Cynoglossum, Borago, Echium, Myosotis Useful species.

Lithospermum.

21. Solanacea. The tribe of deadly nightshade, henbane, tobacco, and potato. Useful and poisonous species. Types—Solanum, Atropa, Hyoscyamus, Datura.

22. Ericaceæ. The heath tribe. Its distinction from Epacridaceæ.

Types—Erica, Arbutus, Vaccinium, Pyrola, Monotropa.

23. Compositæ. The composite family. The number of species and geographical distribution. Structure of the sub-orders Asteracea. Cichoracea, and Cynaracea. Types—Tussilago, Aster, Inula, Gnaphalium, Bellis, Artemisia, Achillea, Carlina, Carduus, Cichorium, Leontodon, Lactuca, Crepis.

24. Stellatæ. The Stellate tribe. Its relation to Cinchonaceæ and ${\it Caprifoliace x}$. The properties and useful plants of Cinchonacex. Types— ${\it Galium}, {\it Rubia}$.

25. Umbelliferæ. Umbel bearing plants. Character of inflorescence and flowers. Nature of fruit. Structure of cremocarp. Properties of the order. Types-Hydrocotyle, Sanicula, Eryngium, Apium, Sium, Æthusa, Œnanthe, Crithmum, Angelica, Pastinaca, Daucus, Torilis, Scandix, Conium, Coriandrum.

26. Cucurbitacea. Melon, cucumber, and gourd family. Useful plants of this order. Type—Bryonia.

27. Rosaceæ. The rose, apple, cherry, and plum tribe. Forms of the fruit. The useful plants of this order. Types-Prunus, Spiraa, Fragaria, Rubus, Geum, Rosa, Cratægus, Pyrus.

28. Leguminosæ. The bean, pea, and clover family. Principal divisions of the family. Structure of the flowers and fruits. Useful plants of the order. Types—Ulex, Trifolium, Vicia, Astragalus, Ornithopus.

29. Crucifera. Cabbage, turnip, and mustard tribe. Structure of the flowers and fruits. Useful plants of the order. Properties. Types-Nasturtium, Alliaria, Brassica, Sinapis, Armoracia, Iberis, Isatis. Crambe, Cakile.

30. Papaveraceæ. The poppy tribe. Properties and mode of collecting opium. Nature of fruit. Types—Papaver, Glaucium, Chelidonium. Ranunculaceæ. The crow-foot tribe. Structure of abnormal

31. Ranunculaceæ. genera; Aconitum, Aquilegia, and Delphinium. Nature of poison in order. Types-Ranunculus, Clematis, Helleborus, Pæonia, Anemone.

Text-books for Systematic Botany.—Lindley's Vegetable Kingdom. For British Botany.—Bentham's Handbook of the British Flora, or Babington's Manual of British Botany.

Subject XVIII.—Mining.

The Art of Mining embraces so wide a field of study that equal practical proficiency in its various branches is not to be expected; but those who wish to gain a general knowledge of it may be recommended to direct their attention to the subjoined heads, viz.:

1. Geology and Mineralogy, more particularly those portions of the sciences which bear on the following subjects,—the nature and position

in the earth's crust of the useful minerals, the classes of rock with which they are severally associated, the special character of heaves, throws, troubles, and all kinds of dislocation; the particular differences between beds and lodes, and their minerals, and the chief features of irregular repositories.

2. The methods of prospecting and searching at surface for ores and

other minerals.

3. Breaking of ground; the various implements employed, their form, dimensions, and weight; boring for shots; the various modes of firing charges. Heavy charges, how calculated and fired; rules for ensuring safety.

4. Deep boring, under what circumstances applicable,—apparatus for;

description of varieties in use; lining of bore-holes.

5. Management and supervision; payment of men employed at mines, at surface and underground, varying in principle with the different classes of operation; reasons for tut-work or piece-work, and tribute or bing-tale under different circumstances. Calculations for cost of driving, sinking, tramming, &c.

6. Physical principles of ventilation; practice of mines where simple natural ventilation is employed; ventilation of large areas and of deep or complicated workings by guiding the natural current; artificial means, and their details, for promoting ventilation. Precautions to be taken under specially dangerous conditions.

7. Illumination, of various kinds, their economy; safety lamps in all their best modifications; circumstances under which they should be

employed; precautions in their use.

8. Mechanical division of the subject. Strength of materials used in mines; human and horse power, principles and construction of machines to which they are applied. Hydraulic machines: construction of the water-wheels, turbines, and pressure engines most suitable to the various operations of mining. Steam engines, for pumping and for winding; arrangement and construction of the varieties most in use. Form and dimensions of boilers. Pumps employed in mines, mode of placing them; construction of the lifts; materials and details of the rods, setoffs, counterbalances, cisterns, and catches. Circumstances under which dams are erected in shafts or levels; mode of building them.

Tubbing of water from shafts; conditions under which it may be done; details of the operation with various materials, wood, brick, stone, cast and wrought iron.

Rails, waggons, and tubs for underground conveyance; employment

of horses and of fixed steam engines for this purpose.

Raising of the mineral through the shafts; various methods in use; chains, ropes (of hemp or wire), their weight, &c. Details of the best application of drums, cages, guides, keeps, and safety doors. Pulleys and shaft frames or poppet heads; protection against over-winding; safety clutches, &c. in case of breakage of rope.

9. Opening of ground; quarries and open work; driving of levels, various dimensions and directions according to circumstances; sinking of shafts, inclined or perpendicular; advantages of either kind under certain conditions; means of securing levels and shafts by timber or by walling; details of the various methods. Driving or sinking in heavy or running ground.

10. Working excavations; plan of laying them out, and means of security to be adopted whilst they are kept open. This will include the stoping of metalliferous veins, and the various modifications of post and stall, long-work, &c., which are applied to stratified deposits.

- 11. Travelling in shafts; prevention of accidents by proper fitting and dividing; mode of placing ladders and sollars; lifting machine for men. construction and advantages of.
- 12. Dressing of minerals. Arrangement of dressing floors. Construction of crusher and stamps; washing of coal; jigging, concentration, and separation of metallic minerals.

The student may be advised among other sources of information to consult the following works :-

De la Beche's Report on Cornwall and Devon. Greenwell's Treatise on Mine-Engineering. Dunn on the Winning and Working of Collieries. Hedley on Colliery Working and Ventilation. Smyth's Rudimentary Coal and Coal Mining. Evidence before Committees of the Houses of Lords and Commons on Accidents in Mines. Reports of H.M. Inspectors of Coal Mines. Transactions of the Northern Institute of Mining Engineers.

Subject XIX.-Metallurgy.

I. Introduction.

On certain physical properties of metals. Action of heat, specific gravity, crystallization, fracture, malleability, ductility, tenacity, conductivity of heat and electricity, opacity, lustre, colour. General considerations on metallurgical processes. Modes of occurrence of metals in nature, ores, reduction, smelting, roasting, liquation, slags.

II. Fuel.

General remarks, calorific power, calorific intensity, classification of fuels, wood, peat, lignite, coal, charcoal, coke, gaseous fuel and gas furnaces, charcoal burning, coke burning, typical varieties of coke ovens, comparison of fuels with respect to calorific power. This important branch of the subject is treated with much detail.

III. Refractory materials employed in the construction of furnaces, crucibles, &c.

Fire-clays British and foreign, crucibles of various kinds, plumbago and its application to crucibles, manufacture of crucibles, fire-bricks, silica and its applications, Dinas fire-bricks, sand and sandstones.

IV. Special Metallurgy.

Copper.—Compounds of special importance in the metallurgy of this metal fully described, such as the disulphide, oxides, &c., ores of copper, copper-smelting in reverberatory and blast furnaces, reactions occurring in the process, kernel-roasting, 'wet' methods, of extracting copper from its ores, assaying of copper ores by 'dry 'and 'wet' methods,

ship sheathing.

Zinc.—In describing the metallurgy of zinc and the following metals, the same plan will be followed as in describing the metallurgy of copper, that is to say, the compounds of special metallurgical importance will be first considered in detail, as well as the reactions upon which the various processes of smelting essentially depend, and the construction of the furnaces will be fully explained. Ores of zinc, English, Belgian, Silesian, and Carinthian methods of extraction, assaying of zinc ores brass, its history, properties and manufacture.

Lead.—Ores of lead, lead smelting in the 'ore-hearth,' low blast and reverberatory furnaces, lead-fume and various methods adopted for its

condensation, assaying of lead ores.

Silver.—Ores of silver; smelting of silver ores with lead; cupellation; desilverization of lead by Pattinson's process, also by that of Parkes;

treatment of argentiferous copper by liquation; extraction of silver; amalgamation, the old Freiberg method and the Mexican; Ziervogel and Augustin's 'wet' methods; treatment of argentiferous copper-regulus; alloys of silver and copper; standard silver; assaying of silver ores and

alloys.

Gold.—Modes of occurrence of gold in nature; extraction by amalgamation and by smelting with lead; chlorine-water as a solvent for the extraction of gold from certain ores; separation of gold from silver or parting by nitric and by sulphuric acids; alloys of gold with the preceding metals; standard alloys; assaying of auriferous ores and alloys.

Mercury.—Ores of mercury; extraction in the Almaden, Idrian, and Hähner furnaces; in retorts in admixture with reducing agents; assaying

of the ores of mercury.

Antimony.—Ores of antimony; liquation of the native sulphide and its subsequent reduction by iron or other agents; alloys of antimony, type metal, &c.; assaying of the ores of antimony.

Bismuth.—Mode of occurrence in nature; its extraction from ores

containing it by liquation; alloys of bismuth.

Nickel.—Ores of nickel; modes of extraction, generally by a combination of 'dry' and 'wet' processes; alloys of nickel, especially those known as German silver; assaying of nickeliferous ores and alloys.

Cobalt.—Ores of cobalt; smelting and preparation of zaffre and cobalt colours, smalts, &c.; separation of nickel; assaying of cobalt ores.

Arsenic.—Mode of occurrence in nature; arsenious acid or 'glass' of arsenic, generally obtained as a secondary product in the treatment of certain other ores, such as those of nickel, cobalt, &c.; modes of condensation of arsenical fumes; preparations of arsenical 'glass,'

Tin.—Ores of tin; smelting in reverberatory and blast furnaces; tin refining; varieties of tin in commerce; alloys of tin, with the preceding

metals, bronze, gun-metal, bell-metal, &c.; assaying of tin-ores.

Iron.—Malleable iron; steel; pig-iron; ores of iron, direct extraction of iron in the malleable state from the ore; smelting of iron in the modern-blast furnace; construction of blast-furnaces and blowing machines; economic application of the waste gases; conversion of pig into bar iron in open hearths and in the reverberatory furnace; manufacture of steel by various methods. This department of the subject will be treated at considerable length.

Various Metals.—Platinum and its associated metals; cadmium;

sodium; aluminium; tungsten; titanium; manganese.

Subject XX.—Navigation.

1. Elementary Principles.—Problems relating to latitude, longitude;

differences of latitude, and differences of longitude.

Relation between an arc of a parallel of latitude and an arc of the equator. Principles of plane sailing and middle latitude sailing. Principles of Mercator's sailing. Mercator's chart. Principles of

great circle sailing. The compass and its corrections.

(1.) Variation. (2.) Deviation. (3.) Local attraction. (3.) Local attraction. (4.) General theory of deviation (Towson's Practical Information, first 50 articles). Correction of courses for variation, deviation, and leeway. The log. Correction of estimated distances run for errors in the log line and glass. Plane sailing. Traverse sailing. Middle latitude sailing. Mercator's sailing, with examples.

To find difference of longitude made on a traverse. Sea journal. day's work. Practice of great circle sailing. Circular arc sailing. Tides. Winds. Cyclones. To find bearing of a circular storm; veering of wind; heaving to; and sailing from centre of gale,

Construction of tables of meridional parts.

Description and use of sextant, with the theory, adjustments, and errors.

Note.—Candidates for certificates as teachers of Navigation will be required to possess a competent knowledge of the whole of the above syllabus, and to have obtained a certificate in elementary mathematics and passed in higher mathematics as far as spherical trigonometry inclusive.

For students.—To "pass," as far as principles of plane sailing. The

compass and correction of courses.

For honourable mention.—As far as Mercator's sailing, with examples. For third, second, and first class Queen's prizes, a proportionate knowledge of the remainder.

Subject XXI.—Nautical Astronomy.

Definitions. Time, apparent, mean, sidereal, &c. Equation of time. To express interval of mean or sidereal time in parts of sidereal or mean time respectively. To convert arc into time, and conversely. To find Greenwich date. To take out right ascension of sun for a given mean Greenwich date.

Correction of altitudes. Dip. Parallax. Refraction. Augmentation of moon's semi-diameter. Reduction of altitude of a heavenly body observed at one place to what it would have been if observed

at another. The chronometer and its use, error, and rate.

Latitude by meridian altitude of sun, and fixed star.

Latitude by meridian altitude of moon. To find Greenwich mean time of moon's meridian passage. To find semidiameter and horizontal parallax of moon for a given Greenwich date. To take out from

Nautical Almanac moon's declination, &c.

To find local and Greenwich mean time of passage of a star over a given meridian on a given day. Latitude by altitude of sun, star, or moon below the pole and by pole star. Latitude by altitude of sun or other heavenly body near the meridian. Calculations of hour angles. Meridian distances. Right ascensions. Computations of time. Error and rate of chronometer. Computation of mean or apparent time at any place from observed altitude of a heavenly body. Longitude by chronometer. Error in hour angle from error in observed altitude. Variation of compass. Azimuth, altitudes, amplitudes, determination of true bearings. True azimuth from altitude of heavenly body and without observed altitude. True bearing of a point of land, &c., by observed amplitude of sun. Deviation of compass, from Art. 50 to end of Towson's Practical Infor-

mation. Sumner's method of finding longitude and latitude.

Method of double altitudes, Ivory's and direct. Error of chronometer
by equal altitudes of sun and fixed star. To compute apparent

altitude of a heavenly body when its true altitude is given.

Methods of clearing a lunar distance from the effects of parallax and refraction. To find Greenwich date corresponding to a given true lunar distance, &c. To find the altitudes when a lunar distance is taken from altitudes before and after taking the distance. To find the longitude by a lunar. Rate of chronometer by a lunar.

OBS.—In all the above problems the demonstration of the rules as

well as accurate practical working is required.

Note.—Candidates for certificates as teachers will be required to possess a competent knowledge of all the above syllabus, and to have obtained a certificate in the elementary mathematics, and passed in higher mathematics as far as spherical trigonometry inclusive.

For students.—To "pass," a knowledge of the elementary principles,

and finding latitude by meridian altitudes of a heavenly body.

For "honourable mention," the above, with variation of compass from altitudes and azimuths, and rate of chronometer, and longitude by chronometer, is required.

For third, second, and first class Queen's prizes, a more or less accurate knowledge of the remainder.

Subject XXII.—Steam.

- 1. General Properties of Steam.—General effects of heat and cold, with practical applications of the principle. Law of expansion by heat not universal. Beneficial result of this anomaly. To ascertain the temperature of any substance. Pyrometer. Thermometer-Description—Graduation. Comparison of thermometers when differently graduated. Laws of cooling. Conduction. Conducting powers of bodies. Convection. Explanation of some natural phenomena by this law. Radiation. Radiating power of bodies. On what it depends. Land and sea breezes. Capacity for heat. Unit of caloric. Latent heat. Under what circumstances heat becomes latent. Heat sole agent in melting and vaporising bodies. Calorimeter. Sources of heat. Combustion. Temperature necessary for it. Boiling point. Temperature of elastic fluids. Vapour. Formation of dew. Distinction between vapour and steam. Boiling points of fresh and salt water. Distillation. High-pressure steam. Measure of steam by atmospheres. Steam when in contact and when not in contact with boiling water. Relation between pressure, density, and temperature of steam. Specific gravity of steam. Common, superheated and surcharged steam. Priming. Analysis of sea water.
- 2. Steam Engine. General principles. Different kinds. Engines in use before Watt. Newcomen's engine. Its defects. Discoveries of Watt. Blowing through. Defects in atmospheric engines. Single acting and double acting engines. Expansion valve. Cornish— Marine steam engine. High-pressure or non-condensing engine. Different descriptions. Side-lever marine engine. Blow-valve. Stuffing boxes. Piston of steam cylinder. Working parts. Working of the slides, strap, gib, and cutter. Escape valve of cylinder. Parallel motion. Hall's condensers. Test cocks. Grease cocks. Grease cups of slides. Annular air-pump bucket. Annular delivery valve. Various kinds of slides. Cushioning. Lead. Lap, its effects. The eccentric. Throw and stops of ditto. To find the travel of the slide. Back-lash. Double eccentric. Throttle valve. Expansion valve and various kinds. Barometer or condenser Method of estimating pressure by it. Errors in this method, and correction of the same. Lubricators, &c. Number of engines in a steamer. Expansion cams and gear. Feed pumps. Bilge pumps. Modes of propulsion. Paddle wheels. Pitch, Reefing. Disconnexion and immersion of wheels. Brakes.—Modes of fitting. The screw propeller. Length, angle, pitch, slip, area of screw Disconnecting and raising screw. Governors. Direct acting engines. Gorgon-Fairbairn's double cylinder, oscillating, trunk engines, &c. Engines for screw propellers. Direct acting, with and without multiplying gear. Oscillating horizontal and trunk engines. Double acting air-pump.
- 3. Boilers.—Description. Gear connected with them. Tubular boiler. Number of boilers. Steam chest. Safety valve. Waste. Steam funnel and drip pipe to steam gauge. Wash or dash plates. The funnel dampers. Reverse valve. Communication or stop valve. Blow-out cocks. Circulating pipes. Brine pumps. Brine valves. Refrigerators.

4. Calculations.—Methods of measuring efficiency of steam engines. Duty of an engine. Horse power. Mercantile or nominal horse power. Horse power from the evaporation in the boiler. De Pambour's theory. Velocity of maximum useful effect. To find evaporation of a condensing engine of given dimensions and horse power, the piston moving with a given velocity with and without expansion. To find the pressure in cylinder, knowing the effective evaporation. To find the diameter of a cylinder to work at a certain speed, knowing the evaporation. To find the evaporation in the boiler, knowing the diameter and velocity of piston and pressure of steam in the cylinder with and without expansion. Same for locomotive, Watt's engines, &c.

The screw—to find its area. Angle of the helix or thread of the screw propeller—to find the pitch. The power exerted by a screw. How far slip depends on form and dimensions of the screw. Motion of paddle-wheels, &c. Consumption of fuel. Measure of locomotive performance of marine steam engines. To find the angle the crank has moved through when the piston is at a given distance from the top of the stroke. Amount of work developed by crank in a half-revolution—length of radius-bar in side lever engine. Work done in the up and down stroke of the air pump. The best temperature for the condenser of a steam engine. Qualities of fuel, &c.

- 5. Practical working.—Getting up steam. Mode of starting. Working engines at moorings. Priming—causes and remedies. Banking up and putting back fires, &c. Duties to machinery when under steam, boiler, fires, &c. Injection pipes. Kingston's valves. Leaks in engines. Bearings of engines. Expansive working. Management of fuel. Damages and repairs to boiler, &c., after accidents. Duties to engine, &c., on arriving in harbour.
- 6. Indicator.—The ends it fulfils. Description. Atmospheric line. Method of taking a diagram. The general configuration of diagram to be expected under various circumstances. The slide-diagram. Examination of Indicator-diagram when steam is throttled; when expansive gear alone used, and in other cases. To ascertain the horse-power of an engine by means of the indicator. To find quantity of water evaporated. Friction of steam engine without load. Diagram when there is no condensation. Diagram showing the relative motions of slide and piston at every point of the stroke.

Dynamometer. To find horse-power of engine by means of it.

The text books specially recommended are—The Marine Steam Engine, by Professor Main and Mr. Brown, R.N., Longmans and Co.; Main and Brown's Indicator and Dynamometer; De Pambour's Theory of the Steam Engine.

Note.—No certificate as a teacher of steam will be given unless the candidate has obtained a certificate in elementary mathematics and theoretical mechanics; and no first grade certificate, unless he has taken a certificate in higher mathematics.

Subject XXIII.—Physical Geography.

The following very brief outline of the principal branches of this subject may be useful:—

a. So much elementary astronomy as relates to the position of the earth in the solar system, its magnitude and rotation, and the influence of the sun and moon on terrestrial phenomena.

- b. So much of elementary physics and inorganic chemistry as includes the nature and mode of action of the physical forces and the composition of rocks.
- c. So much of elementary geology and mineralogy as includes a knowledge of the nature of rocks, their superposition, succession, and disturbances.
- d. So much of palæontology as includes a knowledge of the distribution of life in time.
- I. The distribution of land. Form of land, continental and insular. Elevation of land. Mountains. Plateaux or table-lands. Low plains. Valleys. Deltas. Grouping of islands.
- II. Phenomena of water. Oceans and inland seas. Composition and temperature of oceans. Movements of water. Tides and currents. Waves. Lakes. Rivers and river systems. Waterfalls. Circulation of water on the globe. Ice. Glaciers. Springs.
- III. Phenomena of the atmosphere; its nature and composition.

 Effects of heat on air. Winds. Periodic winds. Storms of various kinds. Electric storms. Magnetic storms. Effects of moisture in the air. Dew. Clouds and rain. Estimate of rain-fall. Climate and weather.
- IV. Volcanic and earthquake phenomena. Distribution of volcanoes. Volcanic groups. Nature of an eruption. Nature of earthquakes. Range of earthquakes. Statistics of earthquakes. Result of volcanic action and upheaval on the physical condition of the land.
 - V. Distribution of vegetation on the globe in space, horizontal and vertical. Influence of climate and soil on natural groups of plants. Representative forms of plants. Range of cultivated plants.
- VI. Distribution of animals in space. Zones of height in the air and of depth in water. Corresponding forms of animal life in different zones or belts. Relation between parallels of latitude and zones of height or depth. Special distribution of certain classes and groups of animals.
- VII. Distribution of plants and animals in time.
- VIII. Ethnology. Families of the human race. Geographical limit of certain races. First introduction of the human family. Modification of the races of men. Influence of man on vegetation and on animals. Extinction of races by human influence. Influence of man on inorganic nature.

SCIENCE FORM, No. 232.

CIRCULAR MEMORANDUM TO SCIENCE SCHOOLS AND CLASSES.

By the advice of the Examiners in Science, the Lords of the Committee of Council on Education have sanctioned the following rules for the examination of Science Schools and Classes in May:—

- 1. That there shall be two examination papers in each subject; one of which (the first) will be an easy paper, the other (the second) more difficult.
- 2. That the candidate shall be allowed to select questions out of either the first or the second paper; but not out of both.
- 3. That the candidate shall be restricted to a certain number of questions in each paper—the number which he may fairly answer in the time allowed—and that the paper shall consist of about half as many more questions. Thus, if eight questions in a paper can fairly be answered in the three hours, the paper will consist of about twelve questions, and the candidate will be allowed to attempt any eight of those, but no more.

4. That the 5th and 4th class shall be obtained from the first paper only, and the 1st and 2nd class from the second paper only; whilst the 3rd class may be obtained from either the first or the second paper.

Thus, for instance, if the candidate is restricted to eight questions in the first paper and to ten in the second paper in a subject, then the number of marks attached to some eight and some ten of those questions respectively will be 100, and 40, 60, and 80 * marks in the first paper will give a 5th, 4th, or 3rd class respectively, while 40, 60, and 80 marks in the second or difficult paper will give a 3rd, 2nd, or 1st class. The 3rd class will thus be obtained either by very good answering in the easy paper or by fair answering in the difficult.

5. Teachers are recommended to explain the system fully to their pupils before they come up to examination, and, if possible, from their knowledge of the students' attainments, to advise them which paper to attempt.



^{*} These per-centages are only given as examples. The scale may vary from time to time.

LIST of SCIENCE SCHOOLS, giving the NUMBER of STUDENTS returned as under INSTRUCTION in MAY 1866 and MAY 1867, and the NUMBER of PRIZES and MEDALS obtained in MAY 1866 and MAY 1867.

	umber of Medals.	1867.									
	Number of Medals.	.1866.		:::	:	:::	::	18.2B.	::	:	:
	Number of Prizes.	1866. 1867.									
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6 are in Italics.	Teacher.			Gubb, Edwin J. Gunn, W. Jones, Thomas	{Easther, Rev. A } {Jarmain, George - \$	Marriott, J. T. Hurst, W. Gibson, G. H.	Butterworth, T. Shore, T. W.	(Beale, J. H. Owen, A. Beesley, T. Brears, W.	Woodward, C. J. Bullpitt, M. T. Bickerton, A. W		Raimbach, D. W.
Schools established since May 1866 are in Italics.	Secretary.		ENGLAND.	Davis, John Ratcliffe, Wm. Railton, G. W.	Jones, J. W.	Footner, Richd. Lauton, Thomas Dalby, John	Howorth, D. F. Newbigging, T.	Cadbury, James " Binder, Rev. 1V.	J. Smith, Edwin - Bembridge, E Smith, David -		- Laundy, E
Schools establi	Chairman.			Strange, W. A., D.D. Ingram, J.		Clarke, T. P Rumnen, Robt Smith, H. E	Mason, Hugh Aitken, John	Harrison, W. B " Hamer, A. G	Martineau, T Winter, Rev. S. W. Scowcroff, Rev. J. H.	222	- Cope, C. B
	Where held.			British Schoolroom - Mechanics' Institution - Day School Room -	King James' Grammar	Mechanics Institution Westegan School Mutual Improvement So-	Ashton-under-Lyne Mechanics' Institution - Bacup - Mechanics' Institution -	British School Science School Laboratory St. John's School	Midland Institute - St. Barnabas' National School. Metropolitan Railway	Works, Saltley. Clarendon Chambers Wesleyan Schools St. Matthew's Schools, Dud.	School of Art -
-	Town.			Abingdon - Accrington - Alderley Edge -	Almondbury -	Ardwick	Ashton-under-Lyne Bacup	Banbury Barnsley	Birmingham Birmingham		•

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Parkinson, Gilos Hand, Thomas- Metkle, William Phillips, Josias Marsden, Peter C. Vickers, James-	Lowe, Rev. J Barton, J Cunnack, R. J	Wilkson, J Gibson, C. W	Briggs, Benjamin W. Graham, John - Masscy, J. Sutherland, J.	Sutherland, J Probert, T. W	Price, Walver - Price, Peter - Moore, H. J	Harris, Rev. Jas. Paton, Rev. J. Mercer, John, jun. Jackson, B. Miles, Rev. S.	Price, G. N. Stoinburne, T. Bradbury, A. Earland, Thos. Marchant, T. W.
Beads, Jas	Powell, Rev. Henry Gadon, John Pridmore, Rev. E. M.	Moseley, Rev. Canon Collis, F. D.	Parker, Rev. A. T Ashworth, Thos Massey, Lord . Shuttleworth, Sir	S E	Davids, C. W Downing, James -	Frost, Meadows Stock, Rev. John Dewhurst, Robert Hadfield, W. Stuart, Rev. A. G. Ramsbotham, James	Carpenter, Dr. Pease, Henry Graham, Bev. P. Money, Rev. C. F. S. Leves, S. S.
Wesleyan School Mechanics Institution 1 Vorking Mer School Literary Institution Bridge Street School Independent Methodists' School	Science and Art School Mechanics' Institute Cornwall	Trade School Literary and Mechanics'	Church of England Literary Institute. Carlton Road School Westgate School Mechanics' Institution	Grammar School Athenæum	Free Library	Mechanics Institution National School Mechanics Institution Westegan Schoolroom National Schoolroom Mechanics Institution	Literary Institution Science Class Mechanics Institute St. John's School St. Paul's School
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List of Science Schools and Classes, &c. -continued.

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Teacher.		Hurst, W. Greeness, C. A.	Sprigga, C H.	Wilcox, E.	Pullen, Muses - Forbes, D. M	Jarmain, G.	Porkins, F. P.	Shaw, H. C. Goo, William	Joffery, Walter Cockman, A.	Jones, Thomas	Weatherill, E Jarmain, George Shore, T. W.	Richardson, J.	Jarmain, George	Richardson J.	CJones, T. Pascoe, John	Fallows, J. H.	Sturgess, Wm.
Secretary.		Bailey, F Longdon, F	Blackburn, Jas.	Hooper, C. H.	Warner, E. Flumptre, Rev.	Kaye, Urish -	Tucker, J. T.	Hooper, W. Wood, Samuel -	Fowler, Hugh - Maddison, Rev. G.	Jordan, C. H.	Webster, T. Glibb, George Binns, John	Fairbrother, G.	Rhodes, Geo. W.	wuson, Edward B. Letch. Geo. V.	Voscy, Rov. F. G.	Lawton, Thomas	Eldred, George Thomas, W. J.
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Chairman.		Nicol, Rev. W. Renals, J.	Ashworth, George	Peters, Rev. Thos	Ford, G Wright, F. B	Farrar, J.	Head, R. T.	Carne, W Atkin, Thomas	Washbourn, B. Burbidge, J. F.	Purviss, Prior -	Chaloner, Thomas - Ackroyd, Edward - Thompson, Rev. E	Smith, Mark .	Smith, A. M. A.	Whitaker, Thomas -	Ward, W.	Hibbert, E.	Lindsay, Rev. H. Davis, Rev. J. W.
Where held.		Mechanics' Institution -	- Educational Institution -		Wesleyan Day School Mechanics' Institute	Mechanics' Institute	Literary Society	National School Littlemoor & Howard Town	Mechanics Institution. Blue-cost School Science Class	Literary Institution -	Mechanics' Institution . Working Men's College . The Institute	Mechanics' Institution -	tution	Working Men's Institute	Walden's School	Mechanics' Institute	National School
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 Town.		Denton - Derby -	Droylsden -	Eastington .	Bastington - Eastwood -	Elland -	Exeter	Falmouth - Glossop	Gloucester . Grantham .	Greenwich .	Guisborough - Halifax - Haslingden -	Heywood .	Huddersfield -	Hull	Hantingdon -	Hyde	Kettoring Kingsbridge

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Packer, M. W. Prosser, W. Ward, George Atkins, Edward Poyner, H. Grawley, Samuel Grawley, Samuel	Birkenhead, E. H Adair, S Jones, John	Davidson, E. A. Martin, J. Snelus G. J.	Pike, Robert W. Simpson, B. (Eastburne, Rev.C.)	Dawe, C. S	Snelus, G. J Howard, J	Bithell, R.	Duckett, W.	Gibsone, Rev. B. W.	• • •	Coles, F.	Newton, John -	Tate, R	Jackson, J.	Holl, Joseph .	Schoffeld, J.	Mellor, J
Bolton, Thomas Moore, J. D. Sales, H. H. Jones, H. S. Pertree, Bev. A. Nelson, Rev. H. Blenkin, Rev. F. Everrard, H.	Gregson, S. L Sharpe, Charles Davies, John -	Wormell, Rich. Bryant, W. J. D.	Runtz, George - Halliday, J.		Rawlins, Hy. E. Ross, John	Hoskins, W. H.	Heller, T. E.	Maskell, Rev. J.	Cousens, J.	Parry, H	Webb, W. H.	Hutchison, T	Brooker, J.	Gregory, John -	Ellis, R. P.	Jarrett, Albert -
Wharton, Rev. G. Turner, Rev. Canon Hole, James Vaughan, Rev. D. Jones, Rev. T. Ashley, W. Mackensie, Rev. H. Kaynorch, J. R. H. R.	Samuell, E. S Samuell, C. S Nevill, C. W	Jenkinson, Rev. J. S.	Rogers, Rev. W Hansard, Rev. S	Mayo, Rev. M. W.	Maurice, Rev. F. D Fleming, Rev. W	Aveling, Rev. T. W.	Scaton, Rev. W.	Whittington, Rev. R.	Mackenzie, Rev. C	Campbell, Hon. D	Maude, Francis,	Gray, R. A.	Wardle, Thomas -	Lindsay, Bev. T.	Callender, W. R.,	Neill, Robert -
National Schoolroom Mechanics' Institution St., Martin's School St., Martin's School Grammar School Grammar School Grammar School Grammar School Hechanica Institution	Free Library	City Middle-class School . Sir Walter St. John's School	Birkbeck Schools National School	St. Mark's Practising School Mayo, Rev. M. W Benham, Rev. W		School. Kingsland and Dalston In-	"M	City of London College -	Royal PolytechnicInstitution	London Mechanics Institu-	Sailors' Home	Upper and Middle Schools	Modern Free School -	Oldham Road National	Roby Educational Society's	Kooms. Mechanics' Institution
Kinver	Liverpool	London:— Bath Street Pattersea	Bethnal Green	Chelsea	Gt.OrmondStreet Islington	Kingsland -	Lambeth -	Leadenhall St	Polytechnic -	Chancery Lane -	Dock Street	Peckham	Macclesfield	Manchester	Manchester	•

List of Science Schools and Classes, &c.—continued.

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Town.	Where held.	Chairman.	Secretary.	Teacher.	Individuals under Instruction.		.0889	.08891 Z 2	Number of Prizes.	Medals.	als.
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Manchester Middlesborough -	Corporation Street - Church of England Institute	Smith, Rev. A. C.	Plant, John . Donaldson, Rev.	Lightbown, J. H	£3 :	98	 			1.B.	
Middlesborough - Middleton - Nelson-in-Marsden	Mechanics' Institution National School Lomeshaye Mills	Gilkes, Edgar - Durnford, Rev. B Ecroyd, W	Tsylor, Wm. Ward, Rev. C. B. Ward, Rev. C. B. Waddington, J.	Weatherill, R Wheeler G. H Clement, J	98	825°	: 40 :			:i:	
Newton Heath Newton Heath		Taylor, Joshua - Taylor, Joshua	Maynard, E. Evans, George- Holt, Samuel	Lightbown, J. H.	3 :23		· : :			: ::	
Nottingham -	Mechanics' Institution		Moyle, Kev. v. H. Thurlow, Richard	Simpson, A Sissling, W 5	3.5					::	
Oldham "	Glodwick Mutual Improve- ment Society's Rooms. Science and Art School	Robinson, John Platt, John	Green, Jeremiah Bailey, Thomas -	Kershaw, T., Jun Mitchell, Thomas }	: 001	8 <u>8</u>	<u>· ·</u> & :	: % : :		1 G. 1 S.	
". Padiham	Parish Church School Analytical Society National School	Schoffeld, James Fox, Rev. J. H.	Walters, Rev. W. Nuttall, William Warburton, Rev.	Mellor, James - Taylor, William - Shore, T. W.	:ឌ :	81 81	19	:::		:::	
Painswick - Pendleton - Pendleton - Pendleton	Free School Mechanics' Institution	Gardner, W Waterhouse, J. Armitage, E., Jun.	Skinner, J. W Harrop, J.	Pullen, M. Jones, Thomas Stator, J. K.	112	8110	: : : : :	2 : :		:::	
Plumstead	Burrage Road School	McAlişter, J. A.	•	Shipman, C	22	29	<u>.</u>			1 B.	
Plymouth	28, Buckwell Street -	Risk, Rev. J. E.	Widlake, T. H.	Hearder, J. N.	:	18		<u>:</u>		:	
Plymouth	Science School	Radford, W	Cawse, J. H. M.	Bickard, G. J (Evers, H	124	154	 8	 8		18,1B.	
Pontypridd Portland Preston Purleigh Rhodes	Navigation School Science School The Grove School School of Science Science Class National School	Hill, Richard Williams, D. W Cuykon, George Jacson, C. R Tamplin, Rev. G. F. Durnford, Rev. E.	Cumming, W. B. Bassett, C. Hill, Rev. Arthur Dunn, James - Luffin, Charles Corbould, Rev.	Merifield, J. Robotham, W. Moffat, Wm. Birkenhead, E. H. Goffin, Robert	:8:83:	2883111:	23 ± 15:			::::::	,

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Bournes, Thomas - Foster, C. Le Neve - Lightbown, J. H.)	Almkill, T	Tomkins, E. Dorrell, J. Smithies, S.	Gee, W. [Davenport, T]	Spullen, M.		7 ~ \ _	Stone, W. Davison, W. Jones, T. Duckett W	Davidson, G	Noble, John - }	{ Bushbridge, W } { Clark, John J } Stockton, W	(Hewison, Rev.G.H) (Bipley, H	•	Beveridge, Dr}	Jones, J. B
Menzies, W. J Boyns, E	Plant, John	Richardson, G. Chapman, J. Dixon, J.	Robinson, S Holland, Rev. P.	r, H. F	Gurney, N	Langley, J. N.	·	Keeble, W. D	Wilson, James -	Norman, J. H	Hall, Robt	SCOTLAND.	Sinclair, J.	Kellas, J. F. Hourston, S. Cumming, A. W.
Mocatta, Rev. W. A. Hadow, Rev.G.	Pickup, Varey	Mather, John W. D. Cree, Rev. J. A. Brown. T.	Leigh, William - White, Rev. W. F.	Dickinson, S	Moorhouse, Rep. J. Sheppard, A. B. Harrey, John Fosson, R.	Hes, Bev. J. H.		Anderson, John	Brown, Rev. H.	{ Robertson, Capt. } { R., R.N } Nuill, H. R	Palmer, Rev. H. V		Matthews, James -	Cook, John - Sturrock, Bev. G Sturrock, John -
St. Thomas's School - The Institution	Working Men's College	St. John's Hall Mechanics' Institution Wesleyan School	Mechanics' Institution The Institution	Strond Institute .	Wesleyan Day School School of Science and Art. 1, Spring Cottage Science School Wissing and Mod. School	Athense and Art Institution		{ Mechanics' Institution, } { Royal Arsenal.	National School	St. Thomas' Parochial School Navigation School	Popular Institution -	•	Mechanics' Institution -	Navigation School Girls' School High School
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•	Andersonien Thiversity		Trents, Gilbert	(Lochore, J.		6				~	
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Kilmarnock Leith	New Public School	Aitken, Bev. James Paton, Walter	MacKay, John - Thomson, Rev. J.	Dunn, H. S. Bolam, J.	8 8	\$ 8	31 :	: 2		::	
			RELAND.								
Antrim -	Science Class -	Ferrard, M.	Wilson, D. M	Savage, H.	:	3	3	<u>:</u>	- -	:	
Armagh	Natural History Society's House	Brown, S.	Davidson, B. P.	Mills, L. G.	2	3	æ	-:	ន	:	
Athlone .	St. Mary's Schools -	Handcock, R.	Berry, Rev. E. P.		:	88	9	-:		:	
Bailieboro	Model National School	Dalton, G. T.	Simpson, A. J.	Doherty, J. J.	:	2:	8:		<u>:</u>	:	
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Ballymena	Model School	Rowan, Rev. R. W	Given, John	Shannon, A. F.	2	33 5	ææ	::	:=	::	
Bandridge	Scarva Street National Sch.	Anderson, Rev. R	Noble, John	Gillespie, Jas.	::	3	8			::	
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Belfast	Belfast Academy, Donegal	Lytle, John	Nesbitt, R.	MoNeill, James -	138	8	6	<u>:</u>	20	:	
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Belfast	Linen Hall Street	Mullan, W.	Shepherd, W.	Browne, W. M.	928	\$ 2	52	::	-	:	
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Taphy :::: \$:: 3:2:::2 : ::: .IIIXX TABLE showing the CLASSES in each of the preceding SCIENCE SCHOOLS, the SUBJECTS taught, and the NUMBER of STUDENTS in PARICEL ::: : :: :: XXII .msət8 : : :: ::::: : nomy. : :: : : ::: : :: : ::: XXI : : : -0148A Nautical ·non ::: ::: : :::::: : ::: XX - RSIVEN General ::: :::: : XIX Metallurgy. ::: : :::::: :::: ::: : ; : ; : ; ; : ::: .ZainiM XVIII. . Lung :::: ::: :::: ::: : ::: XAIL Systematic Vegetable Physi-ology and Eco-nomic Botany. :::::: ::: :::: :: : XAI. : ::• Zoology. :::: ::: : :ន : : : :5 ·ΛX ojo&A· 8 : œ : : : :ន្ត : : : : : ::: XIV. **a**: Pbysilamina ::: : : : : : : : : : : : :::: Mineralogy. : XIII. ::: ::: : :: : : : : : : :: :: Geology. XII. : ::: .IX :: :: ::: : :: : : ::: Organic Chemia-Inorganic mistry. 熔: :02 :::8 : :53 : :23 :23 X Magnetism Blectricity. :8 :: ::: : ::: : : 덛 : :2 IX. pus Acoustics, L and Heat. :: ::: 3:::48 : : : :8 AIII Light, nics. : ::: ::: ::: : : : :: each Subject. .IIV **Applied** ENGLAND chanica. : : : : ::: : ::: : :: ::: : 'ΙΛ Theoretical matica ::: : : ::: : : : : :: : : : : .Ψ Higher Mathe Elementary Ma-thematics. ::: : : :: ::: : :: : : ::: : .VI Building struction. ::: : ::: :::: ::: : :: -: ·III -uoo Sui 28:: Mechanical and -ward enideali : : : : : ::: 15 ::: :::: : Ή. Cleometry. : : 2: : 2: 2 ::::2:: 8 ::: Practical, Plane, and Descriptive .I No. of Individuals under Instruction. **35 G** 52 영역국업 \$28 2 \$88°058 器 Grammar Works, Saltley, n Sehools, St. National dleston, Clarendon Cham-Mechanics Institution British School Science School Laboratory Improvement ciety's Rooms. Mechanics' Institution Mechanics' Institution Mechanics' Institution Wesleyan School Mutual Improvement School of Art Wesleyan School Mechanics' Institution Railway Works, Sr Wesleyan Sahool Matthew's Schools, Where held. British School-room St. John's School Midland Institute St. Barnabas' James's Day School-room School School. Ardwick Ashby-de-la-Zouch Ashton-under-Lyne Alderley Edge Almondbury Town. Barnsley Birmingham Blackburn Bacup Banbury Andover

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For Her Majesty's Stationery Office.
[6351.—500.—8/67.]

SCIENCE AND ART DEPARTMENT OF THE COMMITTEE OF COUNCIL ON EDUCATION, South Kensington.

DIRECTORY,

(Revised to November 1867.)

16th EDITION.

WITH

REGULATIONS

FOR

ESTABLISHING AND CONDUCTING SCIENCE SCHOOLS & CLASSES.

THE RULES IN THE PRESENT EDITION SUPERSEDE THOSE IN ALL FORMER EDITIONS,
BUT ARE ALWAYS SUBJECT TO REVISION.





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1867.

Price Sixpence.



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SCIENCE AND ART DEPARTMENT.

COMMITTEE OF COUNCIL ON EDUCATION,

CROMWELL ROAD, SOUTH KENSINGTON.

Lord President, His Grace the Duke of MARLBOROUGH.

Vice-President of the Committee of Council on Education, The Right Hon. LORD ROBERT MONTAGU, M.P.

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Assistant Secretary.—Norman MacLeod.

Chief Clerk.—G. F. Duncombe (pro tem.)

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Official Examiner .- G. F. Duncombe.

Occasional Examiners.—John Marshall, F.R.S., F.R.C.S.; Rev. J. H. Edgar; T. Clack; G. M. Atkinson; G. Stewart; G. R. Redgrave; Christopher Dresser, Ph. D. Jena.

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Assistant Directors .- R. A. Thompson; P. C. Owen; Captain E. R. Festing, R.E. Director of New Buildings .- Lieut.-Colonel Scott, R.E.

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Provisional Librarian for Art Library. - R. H. Soden Smith, M.A., Trinity College, Dublin, F.S.A.

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Assistant Keeper of Museum Collections.—C. B. Worsnop.

Supplementary Assistant Keepers .- C. C. Black, M.A., Trinity College, Cambridge; R. F. Sketchley, B.A., Exeter College, Oxford; H. E. Acton; J. W. Appell, Ph. D.; A. C. King, F.S.A.

Clerk of Collections.—J. B. Rundell.

Supplementary Clerks.-H. Vernon; A. Masson; F. Coles, certificated in Science; F. Groser, certificated in Art; W. G. Johnson.

Agent for Sale of Examples.—J. Cundall. Official Photographer.—C. Thurston Thompson.

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Deputy Head Master .- R. W. Herman.

Mechanical and Architectural Drawing.—H. B. Hagreen.

Geometry and Perspective.—C. M. Clarke.

Painting, Freehand Drawing of Ornament, &c., the Figure and Anatomy, and Ornamental Design.—R. Burchett, R. W. Herman; W. Denby; R. Collinson; C. P. Slocombe.

Modelling .- F. M. Miller.

Lady Superintendent of Female Students.—Miss Trulock.

Female Teachers.—Mrs. S. E. Casabianca; Miss Channon.

Lecturer on Anatomy.—J. Marshall, F.R.S., F.R.C.S.

Lecturer on Botany.--Christopher Dresser, Ph. D. Jena.

ROYAL SCHOOL OF NAVAL ARCHITECTURE AND MARINE ENGINEERING. Inspector-General and Director of Studies.—Rev. Joseph Woolley, LL.D.

Principal.—C. W. Merrifield, F.R.S.

Vice Principal.—Henry Martyn Taylor, B.A., Fellow of Trinity College, Cambridge.

Instructor in Naval Drawing.—W. B. Baskcomb.

Instructor in Engineering Drawing .- John Maxton. Instructor in Marine Engineering.—J. F. Cotterell.

Instructor in Practical Chemistry.—John Davidson.

Instructor in French.-M. Penon.

Summary of the Nature and Amount of Assistance afforded by the Science and Art Department to the Industrial Classes in procuring Instruction in Science.

[Important Alterations made since the last edition of the Directory are printed in Italics.]

- I. A sum of money is voted annually by Parliament for scientific instruction in the United Kingdom.
- II. This sum is administered by the Science and Art Department.
- III. The head of the Education Department, of which the Science and Art Department is a branch, is the Lord President of the Council, assisted by a member of the Privy Council, who is called the Vice-President of the Committee on Education, and who acts under the direction of the Lord President, and for him in his absence. (Order in Council, 25th February 1856, Act 19 & 20 Vict. c. 116.)
- IV. The object of the grant is to promote instruction in Science especially among the industrial classes,* by affording a limited and partial aid or stimulus towards the founding and maintenance of Science schools and classes.†
- V. The payment of fees by the students result of the second secon

^{*} Direct payments are made to teachers only on behalf of adult artisans, or the children of artisans, or the children of persons who are not assessed to the income tax, that is, who do not possess an income of 100l. a year. (See § xviii.)

[†] The amount is liable to be decreased and eventually withdrawn. Payments to teachers therefore must not be looked upon as perpetual, or in any way conferring on the teacher a claim to any payments beyond those offered for each current year.

my Lords do not consider it necessary at present to lay down any rules making the payment of fees an absolute condition of the grants on account of Science instruction, yet as the payments from the State must be expected to diminish, and as aid on account of those persons who do nothing for themselves cannot be justified, Committees of schools and classes and teachers are strongly urged (should it at present not be the practice) at once to impose as high a scale of fees as they consider can be raised not only on middle class students but also on artisans.

VI. The following are the Sciences towards instruction in which aid is given:—

Subject 1, Practical Plane and Solid Geometry.

2, Machine Construction and Drawing.

,, 3, Building Construction or Naval
Architecture and Drawing.

4, Elementary Mathematics.

- ,, 5, Higher Mathematics.
- ,, 6, Theoretical Mechanics.

, 7, Applied Mechanics.

,, 8, Acoustics, Light, and Heat.

, 9, Magnetism and Electricity.

", 10, Inorganic Chemistry.

" 11, Organic Chemistry. " 12, Geology.

,, 13, Mineralogy.

" 14, Animal Physiology.

,, 15, Zoology.

"

"

,, 16, Vegetable Physiology and Economic Botany.

,, 17, Systematic Botany.

,, 18, Mining.

- ,, 19, Metallurgy., 20, Navigation.
- " 21, Nautical Astronomy.

" 22, Steam.

" 23, Physical Geography.

VII. The assistance granted by the Science and Art Department is in the form of—

1. Payments on results to teachers. (See § viii., xv., xviii. to xx.)

2. Grants towards the purchase of apparatus, &c.

(See § xxii.)

- 3. Public examinations in which Queen's Medals and Queen's Prizes are awarded, held at all places complying with certain conditions. (See § xi. to xvii.) On the results of these examinations the payments are made to the teachers. (See § xv., xviii., and xix.)
- VIII. Persons are qualified to earn payments on results who have:—
- a. obtained certificates as teachers in any of the before-mentioned sciences at the examinations for teachers of the Science and Art Department held previous to January 1867, or,

b. after the abolition of the above examinations—February 1867—obtained a First or Second Class

at the examination* specified in § x1.

No payments are made to a teacher on account of instruction given in subjects in which he is not so qualified.

IX. Suitable premises, with firing, light-ing, &c., must be found and maintained at the cost of the locality where the school or class is held. If at any time the funds do not cover these requisite local expenses, it must be inferred that there is no such demand as the Government is justified in aiding, for instruction in the locality; and the assistance of the Department will be withdrawn.

X. A Local Committee of not less Local Committee. than five well known responsible persons must be formed in connexion with every Science

^{*} Such examination will be dispensed with in the case of a candidate who has taken a degree at any University of the United Kingdom, or who has obtained the Associateship of the Royal School of Mines, London, or the Royal College of Science, Ireland. Full particulars must be furnished by the applicant, and his diploma sent for inspection.

Class, who will carry out the instructions contained in the Appendix.* (See pages 14 and 18 to 22.)

Examination XI. The Science and Art Departof Classes. ment holds annually in May (see Science Form, No. 232, page 59*), through the agency of the Local Committees, a public examination of all Science schools and classes, whether taught by teachers qualified as above or not, in any place in the United Kingdom which complies with the requisite conditions. (See § x., xiii., and xiv.) On the results of this examination the payments are made to qualified teachers. (See § xv. and xviii.) Application for it must be made before the end of March in each year, stating the number of persons and the subject or subjects in which they are to be examined. The form of application, Science Form No. 119 (see page 22*), will be sent on application to the Secretary, Science and Art Department.

In addition to the above, examinations in Mathematics, Navigation, Nautical Astronomy, Steam, and Physical Geography are held for the benefit of seafaring men—and for them only—three times a year in all seaports where Local Committees are formed and are willing to undertake them. These examinations take place in the beginning of March, September, and December. The application for these examinations must be made on Science Form No. 119 before the 10th day of the previous month.

If at any time there be reason to suspect the fairness of the examination generally, or of the way in which particular candidates have worked their papers, a further examination will take place in such manner as may be deemed most advisable. Refusal on the part of any candidate to answer will entail the cancelling of his previous examination.

Examination of Classes.

XII. A school or class taught by a teacher not qualified to earn payments as above, may, by applying to the Secretary of the Science and Art Department, be examined at the

^{*} Science Directory.

same time and in the same manner as the classes under qualified teachers: provided that a Local Committee be formed which complies with the requisite conditions. (See Appendix, page 21,* Science Form, No. 88 a.)

If the class be for artisans the pupils are eligible to receive Queen's Prizes and Queen's Medals under the same condition as the pupils of qualified teachers. Should it however be for the middle classes the pupils are not eligible for prizes and medals, but receive certificates of merit instead.

XIII. If two or more classes in the same Places of town, or within a reasonable distance of one another, apply for the examination of the Science and Art Department, a general examination committee must be formed by the amalgamation of the several Committees to carry out the examinations at some common centre, such as the town hall or other public building. It is only when the classes consist of 50 or more candidates that such amalgamation of the committees will not at present be insisted on.

XIV. Any persons whatever, whether taught by the qualified teacher or not, students. may present themselves at the Local Committee's examination on registering their names in time for the Local Committee to comply with the instructions, and paying a registration fee of not more than 2s. 6d. each. Arrangements must therefore be made by the Local Committee, or the General Examination Committee, as the case may be, to enable other candidates, besides the students in the class for which the Committee act, to present themselves at this examination. The registration fee of 2s. 6d., which such candidates may be required to pay, is to reimburse the Committee for any extra expenses incurred by such attendance, and may at their option be remitted.

XV. The successful candidates at the May examination and the quarterly examinations of seamen are classified under the heads

^{*} Science Directory.

of first, second, third, fourth, and fifth class. The standard of attainment required may be raised from year to year. For the fifth class it is only such as will justify the Examiner in reporting that the instruction has been sound, and that the students have benefited by it. Those who have attained a higher degree of proficiency are classed as 4th, 3rd, 2nd, or 1st class, according to their merit.

Queen's AVI. To the 1st, 2nd, and 3rd class are given Queen's prizes consisting of books or instruments chosen by the candidates from lists furnished for that purpose. These are unlimited in number, and are open to all candidates who come within either of the following categories, (1) Students in Science Classes under qualified Teachers; (2) Registered Students in Artisan Classes taught by any Teachers, or (3) bonâ fide Artisans.

Other candidates, if successful, receive instead

Cards of merit recording their success.

The following are exceptions to the above rule:—

a. Teachers earning or who have earned payments on the results of instruction; and

b. Students who have previously received the same, or a higher class, in the same subject.

—the names of such candidates will simply be re-

corded in the published lists.

Queen's Medals. XVII. To the four best in each subject are awarded Queen's medals. These consist of one gold, one silver, and two bronze in each subject for competition throughout the United Kingdom. They are only awarded if there are a sufficient number of qualified candidates, and the gold medal will only be given in cases of high merit specially recommended by the examiner. The same candidate cannot obtain the same medal in the same subject more than once.

Only registered students of schools and classes under Local Committees (see § x. and xii.) are eligible for medals. They cannot be taken by middle class students who are more than 17 years of age or by teachers who are earning or have earned

payments on the results of instruction. Students who but for this restriction would have taken the medal, will receive an honorary certificate instead. Should a student take more than one gold, silver, or bronze medal, he will receive books instead of a second medal.

XVIII. Payments are made to the Payments to teacher qualified as in § viii. on account of the instruction of students of the Artisan Classes (for definition of Artisan Class see Science Form No. 51, page 23) in the manner specified below:—provided that the student has received 25 lessons * at least from the teacher in each subject in which he claims payment since the last examination, each lesson being an attendance at a meeting of the school of at least three-quarters of an hour's duration on a separate evening. The 25 lessons need not necessarily be all given in one year, but may extend over a longer period.

XIX. 1l., 2l., 3l., 4l., 5l. are the claimable payments for each student in each subject, according to the class in which he passes, but these amounts may

be reduced in the following ways:

1st. If the student has been previously successful in the same subject, such payments are reduced by the normal payment which was claimable on such previous success; for instance, the 4*l*. payment for a second class would, if the student had previously taken a fourth class, be reduced by 2*l*.†

2nd. If a student be successful in more than one subject at an examination, the payments on account of such further subjects are reduced by one half.

† Deductions will be made in payments on account of Subject I. to the amount of any payments that have been made on Second Grade Examinations in Art, in practical geometry, per-

spective or mechanical drawing.

^{*} It must be clearly understood that the number (25) of lessons which the teacher is required to give is the minimum fixed as a criterion that the pupil has received his instruction from the teacher. It is not meant in any way to specify that that amount of instruction is sufficient, or to guarantee the teacher's receiving payment, if that amount of instruction alone is given.

3rd. When on this scale they would amount to more than 60l. the excess up to 40l. is diminished by one quarter, the excess above 40l. by one half. Thus payments which on the above scale would be 100l. and 150l. will be reduced to 90l. and 115l. respectively. * If the teacher be instructing classes three miles or more apart this deduction will be reduced by the amount of his travelling expenses.

Form of Claim payment. XX. The claim of a teacher for the payments under these several heads is made on Science Form, No. 51, which will be sent on application. The voucher must be signed by the secretary and two members of the Committee of the Science Class or School; or by at least three of the Committee. (See Appendix, page 23.)

School Register. XXI. A school register must be kept in each subject on a Form which will be supplied on application. This must be made up from day to day, and will be examined and approved by the Inspector on his visit. It must be sent to the Department with the teacher's claim for payment, and no payment can be made unless it is properly kept.

Grants for Apparatus.

XXII. A grant towards the purchase of apparatus, diagrams, &c., of 50 per cent. on the cost of them, is made to Science Schools and Classes in Mechanics' and similar institutions with a properly constituted Committee (see § x.) A requisition must in these cases be made on Science Form No. 49. (See page 29.)

Instruction in an Elementary School.

XXIII. All payments to qualified teachers on account of Science teaching are made by the Science and Art Department, and are only made in respect of a school in connexion with the Science and Art Department. No such payments are made in respect of any instruction in Science that may be given

^{*} Thus, 100, that is 60+40, is reduced to $60+40-\frac{1}{4}$ of 40=60+30=90. 150, that is, 60+40+50 is reduced to 60+30+25=115.

during the three attendances of an Elementary School receiving aid from the Education Department, Whitehall.

Use of XXIV. These grants are only made Elementary while the teacher is giving instruction School in a day or evening school or class Premises. for the industrial classes (adults or boys), approved by the Science and Art Department, and open at any time to the visit and inspection of its officers. The Managers of an Elementary School under the inspection of the Education Department can permit their premises to be used for Science teaching, provided that no interference be allowed with the primary purposes of such Elementary School, or in any way with the three attendances of the Elementary School.

N.B.—On the next page will be found a table of memoranda for the use of Secretaries and Members of Science Committees (Science Form, No. 170) which it is expected will be carefully attended to. This, as well as the other Forms given in the Directory, can be had on application to the Secretary, Science and Art Department.

*** The Directory for Science Schools and Classes is sold by Messrs. Chapman and Hall, 193, Piccadilly, London, or may be obtained from the Secretary, Science and Art Department, by enclosing six postage stamps.

APPENDIX.

SCIENCE FORM, No. 170.

MEMORANDA FOR THE USE OF SECRETARIES AND MEMBERS OF SCIENCE COMMITTEES.

Dates.

Immediately on the re-assembling of the class after the summer vacation.

Constantly - - -

Before 31st March

Before 24th April -

On the 27th April

During the May examinations.

On the evening of examination.

After the May examinations.

Formation of Committee, Form No. 88. Or continuation of Committee, Form No. 168.

To carefully fill in and send to the Department

Form No. 120.

To visit the School and see that the Register is kept from day to day, and that everything is regular.

To send Form No. 119 applying for examination in

To see that Form No. 91 is hung up in the School-

If a parcel containing (1) the papers for the candidates to work upon, (2) copies of Form No. 91, one for each day's examination, and (3) envelopes in which to return the worked papers, should not have been received, or if there should be any mistake in the numbers sent for each subject as applied for, or in the covering letter, to communicate at once to the Department.

The examination papers for each evening will leave London by the night mail two evenings before, i.e., Thursday evening papers will leave on Tuesday evening, Friday's on Wednesday evening, etc. Should they not arrive accordingly, a telegram to be sent at once to the Department.

The candidates, being all seated at 6.50, to read out the rules on Form No. 91, then give out the papers to be worked on. Then at 6.55 to break the seal of the examination papers and distribute to the candidates. To adhere rigidly to the rules on Form No. 91. To sign Form No. 91. To seal up the papers in one of the envelopes provided and at once post them.

On receiving lists of the results to give one copy to each candidate whose name appears in it as being successful; to inform the others they have failed.

To return Form No. 161 filled up as soon as possible in strict accordance with the rules on Form No. 110. (Prize List). To return Form No. 244a. To examine and certify Teacher's claims for payment, Form No. 51, and the School Register, which must be sent up at the same time. To return Form No. 108.

To keep a record of, and inform the Department of the number of individuals examined.

EXHIBITIONS AND FREE ADMISSIONS AT THE ROYAL SCHOOL OF MINES, LONDON.

ROYAL EXHIBITIONS.

1. There are eight Royal Exhibitions to the Royal School of Mines, Jermyn Street, of the value of 50*l*. per annum, entitling the holders to free admissions to all the lectures, and to the Chemical and Metallurgical Laboratories at the Royal School of Mines, to be held from year to year for three years, on the condition that the holder attends the lectures regularly during those years, and passes the examinations required for the associateship of the School.

At the May 1868 examination three of the above Royal Exhibitions will be open for competition independently of the prizes, &c. offered by the Science and Art Department.

All persons over 21 years of age, excepting artisans, and such as come within the category of persons paid upon under the Science Directory, will be excluded from competing for the Royal Exhibitions. Special cases, however, must be determined according to the spirit of the rules, and the object of the endowment.

The competition for the Royal Exhibitions will be determined by affixing the following values to the several results of the May examination (see Science Directory), viz.:—

To a 1st grad	le in any subject				- 9 m	arks,
To a 2nd "	,,	•	•	•	- 7	29
To a 3rd "	**	-	•	•	- 5	**
Toa4th "	**	-	-	-	- 3	23
To a 5th "	B)	-	•	•	- 1	**
and in addition—						
For a gold m	edal "	` •		•	- 10	
For a silver 1	nedal ,,	• .	•	•	- 7	,,
For a bronze	medal "	• • •	-	-	- 5	,,

N.B.—Science Certificated Teachers may compete for the Royal Exhibitions. When coming up simply with this object, they should inform the Science and Art Department, so that their names may not appear in the published list with the students.

FREE ADMISSIONS.

2. Free admissions to the lectures at the Royal School of Mines, Jermyn Street, are granted to any person who takes a gold medal in the May examination.

But no candidate will be allowed to take a Scholarship who has not obtained at least a 3rd class in Elementary Mathematics.

EXHIBITIONS AND FREE ADMISSIONS AT THE ROYAL COLLEGE OF SCIENCE, DUBLIN.

ROYAL EXHIBITIONS.

1. There are nine Royal Exhibitions to the Government School of Science, Dublin, of the value of 50l. per annum, entitling the holders to free admission to all the lectures and to the chemical and metallurgical laboratories at the Royal College of Science, Dublin, to be held from year to year for three years, on the condition that the holder attends the lectures regularly during those years, and passes the examinations required for the associateship of the college.

At the May 1868 Examination three of the above Royal Exhibitions will be open for competition, independently of the prizes, &c. offered by the Science and Art Department.

All persons over 21 years of age, excepting artisans and such as come within the category of persons paid upon under the Science Directory, will be excluded from competing for the Royal Exhibitions. Special cases, however, must be determined according to the spirit of the rules, and the object of the endowment.

The competition for the Royal Exhibitions will be determined by affixing the following values to the several results of the May Examination (see Science Directory), viz.:—

	To a 1st gr	rade in s	any subj	ect -	•	- 91	narks
	To a 2nd		29	-	-	- 7	99
	To a 3rd	,,	29	-	-	- 5	
	To a 4th	*		•	-	- 8	23
	To a 5th			•	•	- 1	20
and in ac	ldition						
	For a gold	medal,		. .	-	- 10	*
	For a silve	er meda	ļ,	•	-	- 7	
	For a bron	ze med	al, "	-	-	- 5	,,

N.B.—Science Certificated Teachers may compete for the Royal Exhibitions. When coming up simply with this object they should inform the Science and Art Department, so that their names may not appear in the published list with the students.

FREE ADMISSIONS.

2. Free admissions to the lectures at the Royal College of Science, Dublin, are granted to any person who takes a gold medal in the May Examination.

But no candidate will be allowed to take a Scholarship who has not obtained at least a 3rd class in Elementary Mathematics.

T	SCHOOL OF MINES, Jermyn Street, London, and the ROYAL COLLEGE OF SCIENCE, Dublin. ne following candidates at the recent May Examinations are candisfer the Royal Exhibitions at the*
and	they are either—
1.	Under 21 years of age.
2.	Or artisans or operatives in the receipt of weekly wages, supporting themselves by their own manual labour, or their children not earning their own livelihood.
3.	Or, although not artisans, yet such as may fairly be considered as belonging to the industrial classes, as coming within one of the following categories, or being the children of such.
	a. Though paid at longer intervals than a week, still supporting himself by his own manual labour and not by profit on the labour of others, that is, not employing apprentices, journeymen, etc.
-	b. Though not supporting himself by manual labour, yet being of the same means and social level as those who do so, (such as shopkeepers who have only petty stocks and employ no one but members of their own family,) policemen, coast-guards, etc.
	c. Though not supporting himself by manual labour, yet such as it would be unreasonable to expect to pay the fee of middle class students, as some descriptions of clerks, shopmen, etc., and we certify that they or—in case they are not earning their own livelihood—their fathers are not assessed to the income tax.
4	. That they are entitled to be considered as a special case on the following grounds:—
. 1	Ve hereby certify that the above particulars are correct. Chairman or Secretary.† Two members of the Committee.†

^{*} After each name must be stated all the successes of the candidate at the May Examinations and the category under which he claims.

[†] Should the candidate not have been a student in any Science School or Class under a regular constituted Committee, this voucher must be certified by three householders whose occupation and address must be given in full.

SCIENCE FORM, No. 88.

LOCAL COMMITTEES FOR SCIENCE SCHOOLS AND CLASSES.

- 1. A Local Committee of not less than five well-known responsible persons must be formed in connexion with every Science class, in order to comply with the necessary requirements of the Science and Art Department, and to carry out various arrangements on its behalf necessary for testing the efficiency of the science instruction, on the proof of which alone the aid of the Department is given.
- 2. The gentlemen proposed to act on this Committee are to fill in the form on the next page, stating their willingness to carry out the necessary arrangements for examinations, &c., and giving the address and occupation of each member.
- 3. The relation of the Committee to the teacher of a Science school or class will vary much according to the varying circumstances of different localities. In some places where the demand for science instruction is great, and there is an energetic local teacher to take advantage of it, the chief duty of the Local Committee may be to give the teacher the necessary vouchers for obtaining his payments. While in other places, where those who take an interest in and wish to further science instruction may, with that object, subscribe to and establish scientific classes either in connexion with an existing institution or not, and may engage a teacher certificated in science to instruct the classes, the teacher must, to a great extent, be the paid officer of the Committee. With these local arrangements the Science and Art Department does not interfere, but leaves them to the locality to settle. The local circumstances will determine whether, as in the first case, the master receiving the whole of the fees for instruction should provide at his risk the room for instruction, with the necessary firing, lighting, &c., or what, as in the second case, should be the proportion of the fees deducted on this account by the Committee.
- 4. The Science and Art Department requires that the Local Committee shall
 - a. Be responsible for the safe custody of all apparatus towards the purchase of which the Department has paid 50 per cent.
 - b. That they shall provide a room or rooms of sufficient size to carry out the annual examination according to the detailed regulations under that head. This examination is of all persons who wish to present themselves, and not only of those taught by the certificated teacher; but those persons who are not taught by the certificated teacher must send in their names before the 1st March, and may be required to pay a registration fee of 2s. 6d. for the whole examination.
 - c. That a school register, showing the attendance, number of lessons, payment of fees, &c., on an approved form, be kept properly filled up, and sent to the Science and Art Department when required.
 - d. That they shall send in to the Secretary of the Science and Art Department the list of students to be examined, before the end of March, specifying the subjects in which they are to be examined. That they shall be responsible for conducting and superintending the examination: giving out the examination papers which will be

- sent for that purpose: seeing them worked fairly and certifying to the same, not less than three of the Committee being always present: and sending the worked papers, under seal, by the day's post to the Secretary of the Science and Art Department.
- e. That they shall certify, firstly, that those students on whose examination the teacher bases his claim to payments on results, are artizans or operatives, or their children, or can claim as such (see Science Form, No. 51); and, secondly, that they have received 25 lessons at least from the teacher in the year or since the last examination, on their passing at which payment was claimed on their account.
- 5. The Science school or class must be at all times open to the visit and inspection of the officers of the Science and Art Department as a condition to the grant of aid from it; if at any time it is found that the apparatus, &c., towards the purchase of which a grant has been made is not properly taken care of, or that a proper room with firing, lighting, &c., is not provided for the class, the aid of the Department will be withdrawn.

NOTE.—As it is to the Committee that the Department looks to carry out the great proportion of the duties of the school, as many as possible of the members of the Committee should attend on the inspector's visit.

FORM OF APPLICATION to act as a COMMITTEE for a SCIENCE SCHOOL OF CLASS. We the undersigned.

[f. The Committee shall be composed entirely of well-known responsible persons of position who are quite independent of the school or class, and who have no such personal interest in it as can lay them open to the slightest suspicion of partiality; and of course no member should be connected with the Teacher, have any pupils for examination, or be a pupil himself.

g. It is very desirable that as many persons as possible in recognized positions of public responsibility in the district, such as Magistrates, Municipal Authorities (Mayor, Aldermen, or Town Councillors), Heads of Educational Establishments (Trustees of Grammar Schools, Managers of National Schools), Clergymen, &c., should be on the Committee.

h. It is absolutely necessary that at least two such responsible persons should agree to act.

agree to act.

i. The Committee must consist of a Chairman, Secretary, and at least three other Members.

and taught by

The Committee must consist of a Chairman, Secretary, and at least three codes Members.
 The Chairman must be a Magistrate, Mayor, Boroughreeve, Provost, or Alderman, or other public officer of recognized position, Trustee of Grammar School, or Clergyman of the Established Church in parochial employment.
 The Chairman of the Committee will inform My Lords as to the constitution of the Committee being in accordance with these requirements.
 The Secretary of the Committee of the Science School or Class, as being the medium of communication, will carry on all correspondence with the Science and Art Department, and is held responsible for making out and sending all returns required, for the receipt and distribution of the examination papers, the transmission of the worked papers, &c., at the proper times according to the regulations; and in consequence of the necessary demands on his time and trouble My Lords have sanctioned, provisionally, the payment to him of the following fees:—1% annually for furnishing the returns, &c. specified on Science Form, No. 170, connected with any Science school or class, and 1% in addition for each day's examination held by the Committee to which he is Secretary. The Secretary must be a member of the Committee; the requirements in par. 1 apply equally to bim.
 This form is to be filled in and returned to the Department annually before the 15th December, except in the case of new schools or classes, when it should be made as soon as they are formed.]

propose to act as the Local Committee for the Science Class held at

We undertake for the year at least, and further till another Committee satisfactory to the Science and Art Department has been appointed,

- To be responsible for the safe custody of all the Apparatus, Diagrams, &c., towards the purchase of which the Department has in any way contributed.
- 2. That three or more of our number will be ready at the appointed time to be present at, and superintend, the examinations of the Science Class according to the instructions of the Science and Art Department, and give the teacher the necessary vouchers.
- 3. That a room or rooms shall be provided for the due carrying out of such examination, according to the rules of the Department, providing sufficient space for the examination, not only of all persons taught by the certificated teacher, but of all others who may wish to attend the examination.
 - (A fee of not more than 2s. 6d. may be charged on each applicant for examination who is not a student in the class, to reimburse the Committee in any extra expenses they may be put to in providing a room).
- 4. That the School or Class shall be open at any time to the visit and inspection of the Officers of the Science and Art Department.

SIGNATURE.	Address.	Occupation, specially stating how fulfilling the conditions of "g." and "k." above.
Chairman.		
Secretary.		

I certify that this Committee complies with the requirements of the rules f, g, h, i, and k.

Chairman.

The Secretary,

Science and Art Department.

This form may be had on application to the Secretary, Science and Art Department, South Kensington.

SCIENCE FORM, No. 168.

Where the same Committee proposes to act again it will not be necessary to re-sign the above, No. 88, but only to hold a meeting and fill up this form, No. 168, which may be had on application.

SCIENCE FORM, No. 88 a.

LOCAL COMMITTEES FOR SCIENCE SCHOOLS AND CLASSES NOT RECEIVING AID FROM BUT EXAMINED BY THE SCIENCE AND ART DEPARTMENT.

This Form is a modification of the previous, No. 88., and may be had on application to the Secretary, Science and Art Department, South Kensington.

SCIENCE FORM, No. 120.

SCIENCE CLASSES UNDER CERTIFICATED TEACHERS.

ANNUAL REPORT OF SCIENCE SCHOOL OR CLASS, To be made on its establishment, and annually (immediately on the re-assembling of the class after the summer vacation) of its continuation. Name of Town Place, as Mechanics' Institution, &c., in which the Classes are held____ Name of Street, No., &c.__ Name of Teacher or Teachers_____ Their private addresses_ Total No. of individual Students (If a student attends two or more classes he must only be counted as one student.) Period of the Year Hours of Days on which they meet. No. of CLASSES IN during which (state subject). Fees. Meeting. Students. the Classes continue.

NAMES OF SECRETARY AND MEMBERS OF THE COMMITTEE.

(The undertaking on Science Form, No. 88, is for the year at least, and further till another Committee satisfactory to the Science and Art Department has been appointed. This Form, No. 88, must therefore be filled in and sent to the Department annually when the class recommences, except in those cases in which the whole of the Committee, wishing to continue, formally authorize the Chairman and Secretary to report to that effect. It will then only be necessary for new members to sign the form undertaking to perform the various duties.)



SCIENCE FORM, No. 119.

SCIENCE SCHOOL FOR EXAMINATION IN MAY.

To be sent to the Secretary of the Science and Art Department before the end of March.

APPLICATION FROM

·IIIXX	Physical Geo- graphy.	
XXII.	Steam.	
TXX	Nautical Astro- momy	
.xx	General Naviga- tion.	
XIX.	Metallurgy.	
XVIII.		
TIAX	Systematic Bo- tany.	
XAL	Vegetable Physi- ology and Reo- nomic Botany.	
.vx	Zoology.	
.VIX	-isva Physi-	
TIIX	Mineralogy.	
TIX	Geology.	
'IX	Organic Chemis- try.	
'X	-odo oinggronI Triaini	·
IX.	Magnetism and Electricity.	
.IIIV	Acoustics, Light, and Heat.	
.LIV	Applied Mecha- nica.	·
'IA	Theoretical Me- chanica.	
-Λ	Higher Mathe- matica.	
.VI	Elementary Ma- thematics.	
.m	Building Con- atruction,	
п	Mechanical and Machine Draw- ing.	
.I.	Practical, Plane, and Solid Geo- metry.	
		tumber of students under in- struction during the year fumber intending to present themselves for examination fumber intending to present themselves for examination not belonging to the class

Total number of students * intending to present themselves for examination. Total number of students * under instruction during the year...

Name and address of the person to whom the examination papers are to be sent. Name of place where the examination is to be held.

Specify here the arrangements which have been made in accordance with § XIII. of the Science Directory to conduct the examination of any other classes in the town (if there be any) at the same centre. N.B,-The address must be that to which the Examination papers are to be sent.

*Ithe total number of individual students only should be here given, so that if one student attends two or more classes he must only be counted as one.

SCIENCE FORM, No. 51.

SCIENCE AND ART DEPARTMENT OF THE COMMITTEE OF COUNCIL ON EDUCATION, SOUTH KENSINGTON.

Applie	cation from			_ Scienc	e Teac	her in	
certify:				•		is School, We do	•
d	evolving u	on h	im as a Scienc	ce Teac	her in	the School, du	ring the
ti o (3). 1	That he has he year, or on their acc That the un eceipt of a	give: since ount, ider-n	n the following the last exam in each subjec- nentioned stud	g Studention of for who lents are orting the	nts at at which sich pay artizationselve	least 25 lessons th payment was yment is claimed ans or operatives the by their own	claimed . * in the
. *	10041; 01 4	ieir c		niny inei 		Secre	tary.
Thoma	hu contifu	that e	he following p	antianlar		} Co	o mem- pers of mmittee.
in t	e names of	the s	tudents must b	N OR OR	PERATIF	Te STUDENTS.* abetically. After ne has more than cess after making the	each stu-
Surname.	Christian Name in full.	Age last Birthday.	Trade, or father's trade. (State which	Positi the Exami	late	Highest Position in same Subject at any previous	Pay- ment claimed.
	1411.	Bia	is given).	Subject.	Grade.	Examination.	cizimed.
&c.	1					}	

^{*} Should the Teacher have instructed any Students who may fairly be considered to belong to the industrial classes, but whose wages are paid at longer intervals than a week, or who do not support themselves by their own manual labour, the claims on their account must be made by the Committee of the school on the form on page 3, when they will be considered on their merits.

to recording the taken following a. The b. The c. The weak of the control of the	mmend that allowand a salowand a salowand a selong a categorihough paid his own mis not emplote and have only family), pohough not be unreaso some descritify to the That he had have en had a salowand a salowan	at the ces on ring to les, or at le anual loying suppo socia petty blicem suppo best cas give an in the common support or as follow	Teacher, Mr. the following to the industrate being the chil onger interval labour and n ç apprentices, j riting himself l level as those stocks and en eu, coast-guar orting himself to expect to us of clerks, sh of our belief— en them (25) tation at which for which pays in case they as ring particular	studential classes dirent of sthan a ot by prourney by many se who aploy not ds, &c. by mar pay the opmen, lessons the payment is enot es income	rts, who des, as continuous week, soft on men, &cual labordo so so one bound lab fee of &c. at least ent was claimed trans.	m we consider a coming within or within or within or till supporting he habour of or the control of the control	llowed nay fai ne of imself hers, t the so ers (w heir o it wo udents, , or sin r accor od—th	to irly the by hat me rho wn uld , as
							retary.	
			-			}} ^T	wo me bers o	
			the following				ommit	tee.
N.B.—T	he names of me must be	the st	udents must be	arrange	d alphab	NDUSTRIAL CLAS etically. After each ore than one); and e proper deduction ine must be drawn	h stude	nt's
Surname.	Christian Name in full.	Age last Birthday.	Trade, or father's trade. (State which	the	ion at late nation.	Highest Position in same subject at any previous	15 800	Pay- ment
	1	ΨÄ	is given).	Subject.	Grade.	Examination.	0.4	
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&c.								
Sc	The follow	ving 1	Department.	l be fille	d up at	South Kensingto	on.)	
13XHIII)	ueu anu 10'	uia c	orrect to the e		day of		18	<u> </u>
Approv	red				day of_		18	
					,			-



[SPECIMEN.]

Science Form, No. 51. South Kensington, July 1865.

SCIENCE AND ART DEPARTMENT OF THE COMMITTEE OF COUNCIL ON EDUCATION, SOUTH KENSINGTON.

Application from John Smith, Science Teacher in the Science School or Institution at Midhurst for payment.

On behalf of the Committee of Management of this School, We do hereby certify:—

 That Mr. J. Smith has duly performed the various duties devolving upon him as a Science Teacher in the School, during the year ending 31st day of May 1865;

(2.) That he has given the following Students at least 25 lessons during the year, or since the last examination at which payment was claimed on their account, in each subject for which payment is claimed;

(3.) That the under-mentioned students are artizans or operatives * in the receipt of weekly wages, supporting themselves by their own manual labour; or their children not earning their own livelihood.

Wm. Brown, Secretary.

John Jones,
James Robinson,
Committee.

I hereby certify that the following particulars are correct.

John Smith, Teacher.

Names of Passed Artizan or Operative Students.*

N.B.—The names of the students must be arranged alphabetically. After each student's name must be placed his several successes (if he has more than one); and in the last column the amount claimed on each success after making the proper deduction.

Surname.	Christian Name in full.	Age last Birthday.	Trade, or father's trade. (State which is given).	Position at the late Examination Subject. Grade		Highest Position in same Subject at any previous Examination.	Payment claimed.
Adame, " Barber, Smilh,	James, "" John Wm. Henry. William,	22 " 11 13	Carpenter, " Butcher (f) Baker (f)	X. XI. XIV. X. XI. I.	1st 2nd Pass 1st 4th 1st	2nd 	2 s. 5 0 1 0 0 10 0 10 2 0 5 0

[•] Should the Teacher have instructed any Students who may fairly be considered to belong to the industrial classes, but whose wages are paid at longer intervals than a week, or who do not support themselves by their own manual labour the claims on their account must be made by the Committee of the school on the form on page 3, when they will be considered on their merits.

SCIENCE FORM, No. 108.

Application from _	_ Secretary of the Local	
Committee for the Scient	ence School or Class at_	
	nce for duties connected	with the School, and for
Sir,		
Being entitled	to payment according t	o the regulations of the
Science "Directory,*		oith the Science Class at
	and for supering	stending the arrangements
for carrying out the ex-	aminations on	the following days
		may
be paid to me, being the	e authorizea jee.	
Dates of Examination.	Dates of Examination.	Dates of Examination.
	,	
•		
	· · · · · · · · · · · · · · · · · · ·	
	I am, Sir,	
	•	
ML - Cometanu	1 Our	obedient Servant,
The Secretary,) on automont	
Science and Art 1	Эератітені.	
CONDITIONS UND	ER WHICH APPARATUS	, Instruments, Books,

(TAUGHT BY A TEACHER CERTIFICATED IN SCIENCE), 1 IN Public Schools, Mechanics' Institutions, &c.

1. The Lords of the Committee of Council on Education, having had under their consideration several applications from the managers and masters of Mechanics' and other Institutions, for grants to be made to them of Apparatus and Illustrations, recommended by the Science and Art Department for teaching science, think it necessary to adopt some general principle which shall regulate the decisions of the Committee in reference to such applications.

^{* £1} annually for furnishing the returns, &c. specified on Science Form No. 17\$, connected with any Science school or class, and £1 in addition for each day's examination held by the Committee to which he acts as Secretary.

† Apparatus not exceeding 10% in value may be obtained by poor Schools and Mechanics' Institutes, not taught by a certificated teacher, under the same conditions, that its, the Department will aid them to the extent of 5%.

Their Lordships have already fully recognized the great importance of practical science to all classes of the community, in all relations of life. They are, therefore, desirous that the Science and Art Department should assist, as far as possible, in promoting the distribution of diagrams and apparatus as the means of accomplishing this object; but as the indiscriminate gift of these aids for instruction to all applicants might lead to abuse, it is necessary to require some guarantee that they will be duly appreciated, which the mere request to have them does not imply.

The principle which governs the whole proceedings of the Department in all its branches is to afford partial aid, and to encourage, but not supersede public exertions in promoting education in science. They have, therefore, resolved that the Department shall have the power to assist schools and classes taught by a certificated teacher in Mechanics' and other institutions in purchasing diagrams and apparatus for teaching science at a reduction of 50 per cent. on the net cost.

Lists of the scientific diagrams and apparatus prepared by the Department, according to conditions of the following Minute, may be obtained of the Science and Art Department, South Kensington, London, W. It should be distinctly understood that the aid of the Department in purchasing these articles at a reduced price, if above 10*l*. in value, can be granted only to public schools and institutions when taught by a certificated teacher.

Minute of the 23rd March 1860.

"The Lords of the Committee of Council on Education desire to afford the greatest facilities to teachers of science and navigation schools in obtaining the best instruments, apparatus, &c., for giving instruction in science and navigation, towards the purchase of which the Science and Art Department is authorized to pay 50 per cent. of cost; and they consider that the fullest opportunities should be given to manufacturers in all parts of the Kingdom for supplying such apparatus, &c. At the same time it is necessary that the Science and Art Department should have some guarantee that the apparatus and instruments are of good quality, and moderate in price. My Lords have therefore laid down the following rules and conditions:—

- "1. Samples of all articles on the manufacturer's list are to be sent to the Educational Collection, South Kensington Museum, for exhibition, where they will be arranged separately, according to the science for which they are intended, so as to afford teachers and others facility in inspecting them and making a choice.
- "2. The manufacturer is to supply priced catalogues of such articles printed in demy 8vo., in order that the various catalogues may be bound up together and supplied when asked for.
- "3. The manufacturer is to guarantee that the articles exhibited are fair samples of those specified in the priced catalogue, and he must engage to take back any article supplied to schools which may be inferior to the standard."

Manufacturers willing to comply with these conditions are to make a statement to that effect, and to send lists of apparatus, instruments, books, &c. in the following sciences:—1. Practical plane and descriptive geometry, mechanical and machine drawing, and building construction; 2. Physics (mechanical and experimental); 3. Chemistry; 4. Geology and mineralogy; 5. Natural history (zoology and botany, vegetable and animal physiology); 6. Navigation and nautical astronomy, and physical

geography. If these lists and prices are such as can be approved of, the manufacturer will be informed, and as soon as possible on his fulfilling the conditions, his list will be inserted in the catalogue. The catalogue will undergo a revision at least once a year, when manufacturers may send any improved forms of apparatus, &c.

The selection of the manufacturer will lie wholly with the Committee of the school. On their demand being sanctioned, the manufacturer will receive instructions to supply the articles upon his receiving the 50 per cent. due from the school.

On obtaining a receipt from the Committee of the school (which is included in the form of the requisition) that the articles have been received, the remaining 50 per cent. will be paid quarterly to the manufacturer by the Department.

2. Payments, including charge for packing, must be made in advance to the agents on receipt of the invoice. The goods to be sent at the risk of the purchaser.

All communications to be addressed to the Secretary of the Science and Art Department, South Kensington, London, W.

By Order of the Committee of Council on Education.

N.B.—Apparatus grants will in future be rigorously confined to articles of a permanent and non-destructible nature; hence no aid will be afforded in the purchase of breakable articles, such as glass retorts, test tubes, &c., or, indeed, generally in the purchase of articles to be used by the student as distinguished from those of a permanent and illustrative character which are required by the teacher in giving instruction in science.

Grants are only made in the purchase of one object of the same kind. Duplicates of apparatus, &c. are not allowed at the reduced rate.

SCIENCE FORM, No. 49.

FORM of REQUISITION which may be had on application to the Secretary, Science and Art Department.

The following Requisition for Aid in purchasing apparatus, &c., after being filled up as required, is to be transmitted to "The Secretary of the Science and Art Department, South Kensington, London. W."

N.B.—It is to be understood that the Department has a lien on the apparatus, &c., furnished to public institutions to the amount of the public aid given in supplying them; they cannot therefore be sold. 1. REQUISITION for AID in purchasing apparatus, &c. No. 1 appli-School or Institution (*) For the use offilled in by In the City or Town of (*)-Requisition-In the County ofist, with full par-ticulars. Male Female Having (a) Pupils (Artizansor Operatives) of the Science (a) Erase the Class. words that do not apply. (*) Scholars or Members of Poor School or Meand chanics Institute. Total. I request the aid of the Department in obtaining from M the apparatus, &c., named in the opposite page, and I undertake that the same shall be kept and used in the above-mentioned (*) school or institution for which they have been demanded. The address to which the parcel is to be sent is as follows:-To be forwarded to per-Signature of Requisitionist. Dated this day of Agent, No. 2 to be Requisition sent to Mfilled in by day of . 18A the Departand authority given for the supply of Articles to the extent ment. Net Sum will be paid by the Department, and & of which &_ together with the cost of packing, by the school or institution, previous to the goods being applied. – Assistant Secretary. 3. Invoice of articles sent to Requisitionist as under, this day No. 3 to be filled in by 188 of_ Articles (Retail Price) agent on Deduct as above,transmission of the Aid by Department invoice. Add, for packing Total to be paid by Requisitionist received from schools this 4 Amount P. day of Nos. 4 and 5 186 . to be filled - Agent. in by agent. 5. Examples forwarded as directed above, together with Requisition, this-Agent. 6. Examples as per invoice received, and *Requisition returned to Agent, this-No. 6 to be 186 . day of filled in by Requisition-Requisitionist.

It is requested this paper may be returned to the Agent in an entire state after the

examples have been received.

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SCIENCE FORM, No. 91:

Rules for the Conduct of Science Examinations.

1. The following rules must be hung up in the examination room for the information of the candidates one week before the examination. They should all be carefully read by the members of the Committee. Those marked with an asterisk must be read aloud before the Committee and the candidates on each night immediately before the examination

2. A room or rooms of such a size that, when seated, the candidates shall be at least five feet apart, from centre to centre, must be provided

for the examination.

3.* All Diagrams, &c. must be removed from the walls of the examination room.

4. Ink and blotting paper must be provided. All arrangements for the accommodation of candidates must be completed by 6.30 p.m.

5. If one room is used three of the Committee must be present during the whole of the examination, if more than one room then two of the Committee per room,† who must carefully watch the whole examination and see that candidates use no unfair means either by assisting one another or using books or notes. The members of the Committee can, if they wish it, relieve one another, so long as the correct number are always present. No persons not on the Committee are permitted to be

6. The examination papers will be forwarded, under cover, to the Secretary of the Committee so as to be received by him on the morning

of the day before that fixed for the examination.

7.* The candidates must be seated at their places at 6.50 p.m. After this time no candidate shall be admitted except under very exceptional circumstances, and that only by express permission of the Committee, and if no person who has seen the examination paper has left the room. No candidate may on any account be admitted after 7.30 p.m.

8.* The examination papers must be opened in the examination room in the presence of the Committee, at 6.55 p.m. No examination paper

may be taken from the room till after 8 p.m.

9.* When the candidates are seated and the papers given out, the Committee will see that the candidates commence by filling in their names, &c., where directed. All the worked papers must be collected at 10 p.m., initialed, put under cover, and sealed in the presence of the members of the Committee; and forwarded by the first post to the Secretary of the Science and Art Department.

10.* Candidates must on no account bring anything with them into the examination room, texcept pens and pencils. No scribbling paper, slates, or anything of that nature must be allowed. Arrangements must be made by which all books, note-books, &c., can be given up and left at the

door.

11.* Candidates must not on any pretence whatever speak to one another after the papers have been given out. If a candidate should require to ask a question, he will hold up his hand, when a member of the Committee will attend to him, but no question on the meaning of any portion of the examination paper must be asked or answered.

12. It may be of service to the Committee that the teacher of the

[†] When there are not more than three candidates it will not be necessary for more than two members of the Committee to be present at the examination.

‡ Except such as by the Time Table (Science Form, No. 90) are required.

§ It is absolutely necessary that nothing that can be passed from one candidate to another should be allowed. Rough work and calculations must be done on the supplied form, the back of each leaf of the form, i.e., pages 2, 4, 6, and 8, may be reserved for this purpose, the pen being drawn through to show that they are not for the examiner. Here nothing must be torn off the form.

class should attend before the examination begins to assist in getting the candidates into their places, &c.; but from the peculiar character of the examination it is so very necessary that not the slightest opportunity for misconstruction should exist that it is evident that he should not be in the room after the examination papers are opened. Information of his having remained in the room after this will at once lead to the examination being declared null.†

13.* The examination papers being given out no candidate must be allowed to return after having once left the room. Ton a candidate

leaving the room his papers must be taken up.

14.* At 10 p.m., precisely \$\\$, all the candidates must cease working, and members of the Committee will collect their worked papers from them at their places. It will therefore be advisable to warn them ten minutes before the time. The papers will be initialed, by the Committee as directed, as they are received from each candidate, as a guarantee that each has been worked by him whose name, &c. it bears. Should a candidate have completed his work before 10 p.m. he may, by permission of the Committee, go away at once, after his worked paper has been taken by a member of the Committee.

15.* Should a candidate break any of the foregoing rules, ask from or give information to another, or use unfair means of any description, he must be at once expelled the examination room, and his paper cancelled,

and the Committee will state on it the cause of his expulsion.

16. On these examinations depend large grants of public money. On their being fairly, honestly, and impartially carried out depends the continuance of the system. The Committees are intrusted with this duty. They will see, then, how necessary it is to be extremely careful in conducting them, and to insist on the foregoing rules being complied with to the letter. They are therefore required to sign and forward this form with each set of worked papers.

We, the undersigned, members of the Committee of the Science School or Class held at

hereby	certify	that	we	were	present held in	durir	ng the	examination in
on the papers been st	evening were wor	of the rked in mplied	oui l witl	prese	ence, and	that	where the fore	the accompanying going rules have
	Ι	ated t	his _		d	y of		186
			Si	gnature	es.			Time Present.
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‡ It will, therefore, be desirable to make some arrangement for the candidates to retire within the room.

§ Except in the Drawing Examinations, subjects 1, 2, and 3, then the hour is 11 p.m.

[†] Should the teacher of the class wish to compete at this examination for the Royal Exhibitions, he must apply specially to the Committee for permission, so that they may arrange to have a table for him close to their own seats, and not with the other candidates.

SYLLABUS OF THE SUBJECTS IN WHICH EXAMI-BY THE NATIONS IN SCIENCE ARE HELD DEPARTMENT OF SCIENCE AND ART.

THE following Syllabus has been prepared in order to afford candidates some guide to their reading; but it must be understood that the questions in the examination need not necessarily be on the specific points

enumerated.

The examination is by paper, but oral examination may be resorted to. The examination in each subject is distinct. Mention is made of textbooks solely to afford a candidate some assistance in selection and a general idea of the scope of the examination, and not at all to confine his reading to those works or to assert that they are the best on the subjects

they treat of.

A Course of Lectures as detailed below, on "Preparation for obtaining "Science Certificates and the Method of teaching a Science Class," has been delivered by direction of the Lords of the Committee of Council on Education. The lectures may be purchased, price 2d. each, at the book stall, South Kensington Museum, or on application by letter, enclosing postage stamps, to the Secretary, Department of Science and Art, South Kensington, London, W.

Geometrical Drawing, &c. Prof. T. Bradley.

- Rev. B. M. Cowie, M.A. Mechanical Physics Chemistry -- Prof. Hofmann, F.R.S.

Prof. Ramsay, F.R.S.Prof.W. W. Smyth, M.A.,F.R.S. Geology

Mineralogy, &c. Zoology - Prof. Huxley, F.R.S.

Botany - Edwin Lankester, M.D., F.R.S. Navigation and Nautical J. Riddle, F.R.A.S.

Astronomy.

- Dr. G. Kinkel, F.R.G.S. Physical Geography

A Second Course has been delivered, of which the following have been published:-

Lecture I. - Vegetable Physio- Edwin Lankester, M.D., 3rd February. logy and Econo-F.R.S. mic Botany.

Lecture II. Mechanical Physics Rev. B. M. Cowie, B.D. 10th February. Lecture IV. Mining - W. W. Smyth, M.A., 24th February. F.R.S.

SYLLABUS.

Subject I.—Practical Plane, and Solid Geometry.

Practical Geometry, plane and solid; required by architects, engineers, mechanists, shipbuilders, and others employed in arts of construction.

The candidate is assumed to have acquired readiness in the use of the usual drawing instruments and materials, to be skilful in drawing lines and circles in Indian ink, plain or dotted, of different degrees of fineness; drawing parallel equi-distant lines, at least six inches long, and from five to twenty or thirty in an inch; drawing from ten to thirty lines, passing through one point and forming equal angles; dividing by trial lines and arcs into any number of equal parts. He should also be able to mend his drawing pens and other instruments, and to verify his rulers, &c. Two or three questions in the first or easy paper are intended to test his skill in these respects.

Constructions in Plane Geometry.

 To draw lines through given points, in every position, either parallel, perpendicular to, or to form any proposed oblique angle, with given lines.

The use and construction of the protractor, and of the "scale of chords" for these purposes, should be understood, and the deduction of certain angles from the direct division of the circle.

To draw circles or arcs, through given points, to touch given lines or circles, and, conversely, lines to touch circles.

Required in drawing framework for machinery, architectural designs, ornamentation, &c.

 The principles of drawing symmetrical forms by means of co-ordinates to the axis of symmetry.

This is the basis of all drawing, of objects of construction, which are always symmetrical, not only in architecture, civil and naval, but in machinery and engineering works of all kinds.

 Constructions of figures similar to given rectilinear or mixtilinear figures.

Here the construction and use of "scales" plain and comparative, should be thoroughly understood and explained, and the principles of the diagonal division of scales. Also the mode of reducing or enlarging drawings by means of similar rectangles, termed squaring a drawing. The use of the sector and of proportional compasses in facilitatin copying should be known.

- To construct rectilinear figures similar to given ones, but with a proposed area.
- 6. To determine by construction numerical quantities such as \sqrt{m} ; $\sqrt{\frac{a^2+b^2}{a}}$, &c.

- 7. To construct a triangle, any three parts being given.
 - § 1. Used in levelling, surveying, and the determination of eights and distances. Great accuracy, neatness, and distinctness of construction, will be insisted on: Geometrical drawing is valueless unless it possesses these requisites.
 - § 2. A few illustrations of constructions on the ground, by means of a "chain," pins and cords, necessary in surveying, and "setting out" buildings and earthworks, may be added to the course, as well as the solution of a few elementary problems by means of the compasses alone.
- 8. The delineation of a few of the curve lines required in the arts, such as the ellipse, cycloidal curves, the involute and sinusoid, with the graphical method of determining their tangents and normals.

Required in designing elliptic arches, oblique bridges, teeth of wheels, cam-work, screws, &c.

9. Practice in tinting and shading with Indian ink, so as to express curved surfaces and shadows.

Both papers contain questions from sections, 1, 2, 4, 5, but those of the second or more difficult paper are chiefly from sections 4, 5, 7, and 8, and only rarely from 3, 6, 7, and 9.

For the preceding part of the course, a fair knowledge of the first four books of Euclid is necessary, some acquaintance with elementary trigonometry is also desirable.

Constructions in Solid Geometry.

(Descriptive Geometry.)

- A general knowledge of the principles of projection on two (co-ordinate) planes, as necessary to define or represent any geometrical solid, is necessary to gain any certificate in this subject. These projections are termed plans, elevations, profiles, or sections.
- The questions in the first or easy paper demand only this elementary knowledge, the candidate being required to represent by their projections simple solids, such as prisms and pyramids, or others formed by their combinations.
- But to obtain a second or first class the candidate must be acquainted with the methods of solving problems on the combinations of points, lines, and especially planes, independent of any solid form or volume of which they are the elements.
- He should also know something of the geometry of curved surfaces, as the sphere, cylinder, and cone, and of the mode of representing all surfaces graphically by the projections of their generators. For the following subjects he must know how to determine planes to touch or tangential to such surfaces; but candidates are not expected to be more than generally acquainted with these subjects. Occasionally, however, easy questions in the following are inserted in the second paper.
- Applications to the intersections of surfaces, and of the development of such as admit of it.

This may be considered the most important part of descriptive geometry to the artizan, as it is required in all arts of construction. The mason, carpenter, and shipwright, workers in tin-plate, boiler makers, &c., must all possess some knowledge of it.

The solution by construction of the spherical triangle from any three given parts, is mentioned.

As important to masters, mates, and others engaged in any kind of astronomical calculations.

Isometric Projection

Is usefully employed in the representation of works, chiefly of a rectangular form, such as timber framing, canal-locks, and many parts of machinery; its use is increasing: it is readily understood, and can be practised by anyone who has gone through the previous articles of this section.

Perspective or Radial Projection

- May be taken up, but will not be insisted on as it is rarely used except by architects to represent buildings (not yet executed), as they would appear to the eye at any spot from which they could be viewed, and the power of applying it for this purpose is possessed by many who know little of the really easier subject of descriptive geometry; but as its application by the architect must be subordinated to artistic taste, this consideration excludes it, in some measure, from a purely geometrical course.
- No one, however, can be considered a scientific draughtsman unless he can apply perspective projection to the projection of shadows, the projections of the sphere, the constructions of maps and dials, and some other uses.
- For the second division of this course, in addition to what was before indicated, a competent knowledge of the theorems relating to the line and plane (Euclid, Book XI.) is essential.
- The following are some of the best works on the subject of Practical Geometry, but the list is not given as a complete one:—
- For Theoretical Geometry.—1. Geometry, Plane, Solid, and Spherical, &c. (Library of Useful Knowledge), published originally by Baldwin and Cradock, undoubtedly the best work on the subject.—2. Geometry, &c., by Mr. Bell, in Chambers's Educational Course, both comprehensive and excellent.—3. There are excellent elementary works based on Euclid in Gleig's School Series, and in that published by Messrs. Galbraith and Haughton in Ireland, also in Weale's Series, &c. &c.
- For Practical Geometry.—Bradley's Geometrical Drawing, published for the Committee of Council on Education by Messrs Chapman and Hall.—Bradley's Practical Geometry, Perspective and Projection (Library of Useful Knowledge).—Hall's Elements of Descriptive Geometry for Students in Engineering.—Heather's Descriptive Geometry for Students in Engineering in Weale's Series.—Also works by Winter, Burchett, and Binns.
- French works on this subject are numerous and excellent, by Lacroix, Lefebre de Fourcy, Leroy, Le Vallée, Adhemar, Bardin, &c. &c.

Subject II .- Machine Construction and Drawing.

The application of the foregoing Subject I. to the drawing of machinery, in which great accuracy and neatness of drawing will be insisted on.

The candidate will be required to take measurements with calipers, &c., and to make drawings, elevations, and sections of a simple machine, or of parts of one, set before him. Also to draw a portion of a machine from written dimensions and description. He will be required to have sufficient knowledge of the principles of machine or portions of a machine from a rough sketch, applying the power to the greatest advantage, and obtaining such power or changes of motion as are required. In fine, such knowledge and readiness as would be required of a good draughtsman in an engineer's office.

Subject III.—Building Construction, or Naval Architecture and Drawing.

(See previous Subject.)

The candidate will be required to possess sufficient knowledge of construction—(1) to apply the various materials used in building to their greatest advantage; (2) to be able to make detail and working drawings showing a knowledge of the methods of construction and the framing of ordinary roofs, bridges, &c., whether of wood, iron, or masonry; (3) to frame estimates and take out quantities.

Neatness, accuracy, and facility in drawing will be insisted on, and the general requirements in this Subject will be such as would be possessed by a good draughtsman in an architect or builder's office, with a slight scientific knowledge for the proper application of the

materials he is required to work with.

N.B.—Naval Architecture may be taken instead of Building Construction; the same description of attainments will be required.

Subject IV .- Elementary Mathematics.

Arithmetic generally.

 Geometry.—The properties of lines, triangles, rectilinear figures, the circle; properties of similar figures; proportion of figures; inscribed and circumscribed polygons. The questions will have reference to Euclid's elements; but a sound knowledge of Geometry obtained

from any source will be accepted.

3. Algebra.—Definitions. Addition. Subtraction. Multiplication. Division. Greatest common measure. Least common multiple. Theory of indices (integral). Involution. Evolution. Simple equations, and problems producing them. Fractions. Quadratic equations, and problems producing them. Ratio. Proportion. Variation. Arithmetical, geometrical, and harmonical Progressions, Permutations, and Combinations. Binomial theorem for a positive integral index.

4. Plane Trigonometry.—Definitions. Conversion of degrees and their subdivisions into grades, and their subdivisions, and vice versa. Angular and circular measures of degrees and their relation. The goniometric functions of angles and the conversion of one into another. The arithmetical values of the goniometric functions of 90°, 45°, 60°, 30°, 180°, 120°, 150°, &c. The meaning of contrariety of signs in trigo-

180°, 120°, 150°, &c. The meaning of contrariety of signs in trigonometry. Tracing of the goniometric functions in magnitude and algebraic sign through the four quadrants and when an angle is

indefinitely increased.

Formulæ for multiplication and division of angles, viz., sine, cosine, tangent, &c., of $(A \pm B)$, 2A, 3A, $\frac{A}{2}$, and $\frac{A}{3}$. Also of A and B in

terms of
$$\frac{A+B}{2}$$
 and $\frac{A-B}{2}$.

- Logarithms.—Definition. Multiplication, Division, Involution and Evolution by logs. The use of logarithmic tables. Tables of proportional parts for numbers and angles. Modulus. Construction of logarithmic tables, and of tables of logarithmic sines, cosines, &c.
- Triangles.—Formulæ for cosine of an angle of a triangle in terms of its sides. The relation between sines of angles and the opposite sides; sine, cosine, tangent, &c., of half an angle of a triangle in terms of sides, and of the sine of an angle. Area of a triangle. Solution of triangles. Diameters of circles inscribed in and circumscribed about a given triangle. Areas of regular polygons inscribed in and circumscribed about a given circle. Area of a circle. Description and use of vernier and theodolite and sextant (generally). Heights and distances of inaccessible objects.

For students to obtain a 5th class, a competent knowledge of the following alone will be required:—

(1.) Geometry. The first book of Euclid.

(2.) Algebra, to simple equations and problems (inclusive).

(3.) Plane trigonometry. The more elementary portions, including use of logarithms.

To obtain a 4th class:-

(1.) Geometry. The first three books of Euclid.

(2.) Algebra, to quadratic equations.

(3.) Plane trigonometry as far as solution of triangles, inclusive.

And for third, second, and first class Queen's prizes the remaining portion of the above subjects.

Subject V.—Higher Mathematics.

- Algebra.—Surds. Theory of indices (fractional and negative). Binomial theorem generally. Multinomial theorem. Exponential theorem. Indeterminate equations and problems. Indeterminate coefficients. Reversion of series. Properties of numbers.
- 2. Plane Trigonometry.—De Moivre's theorem and the expansion of sine, cosine, and tangent in terms of the angle.
- Spherical Trigonometry.—Definitions and fundamental propositions.

 Polar or supplemental triangle and its properties. Area of a spherical triangle. Spherical excess.

Fundamental formulæ expressing the relations of the sides and angles of a spherical triangle.

Napier's analogies.

Solution of right-angled spherical triangles and of oblique angled triangles.

- Mensuration.—Trapeziurus. Regular plane rectilinear figures. Irregular plane curvilinear figures (Simpson's or Stirling's Rules). Volumes and surfaces of Parallelopipeds, Pyramids, Cylinders, Cones, and Spheres.
- Differential and Integral Calculus.—Definitions. Differential of elementary functions, including circular and logarithmic functions. Vanishing fractions. Maxima and minima of one independent variable. Tangents and normals of curves. Differential coefficients of Areas, Arcs, Volumes and surfaces of solids of revolution.
 - Integration of elementary functions. Integration by parts. Rational fractions. Integration between limits. Areas and lengths of simple curves. Volumes and surfaces of solids of revolution.

Subject VI.—Mechanics as a Science, or Theoretical Mechanics.

Statics. Composition and resolution of forces. Forces acting on a point—on a rigid body. Parallel forces. Centre of gravity. Theory of moments or couples. Principle of virtual velocities. The mechanical powers. Friction. Equilibrium of roofs and arches.

Dynamics. Laws of motion. Uniformly accelerated motion. Motion by gravity Variable forces. Projectiles. Centrifugal force. Motion on inclined planes-on curves. Pendulums. Motion of rigid bodies, free or constrained. Moment of Inertia. Centre of oscillation-of percussion. Motion of flexible bodies, such as a musical string.

Hydrostatics, Hydrodynamics, and Pneumatics. Mechanical properties of liquids. Law of pressure. Centre of pressure. Laws of floating bodies. Capillary attraction. Laws of fluid motion, through open

channels, closed pipes, or orifices.

Mechanical properties of elastic fluids. Theory of barometers. nexion between pressure, temperature, and volume. Specific heat. Weight of atmosphere. Use of barometer in calculating heights.

In this subject the candidate will have to show a mathematical knowledge of the laws of Mechanics, and must be able to prove from

first principles the principal theorems.

The books recommended for study are—Whewell's Elements of Mechanics, or Snowball's; Moseley's Engineering Architecture; Natural Philosophy, by Dr. Golding Bird and Mr. Brooke; Goodwin's Elementary Course.

Subject VII.—Mechanics as an Art, or Applied Mechanics.

General principles of mechanism. Elementary combinations. When the connexion is by rolling contact, sliding contact, wrapping connectors or linkwork, with constant or varying velocity ratio, and constant or

varying directional relation.

Machines of ordinary occurrence must be thoroughly understood and particular parts to be described and drawn: such as cranes; lathes; drills: planing, punching, boring, shaping, and slotting machines. Spinning and weaving machinery. Mode of calculating power of

machinery. Dynamometers, indicators, &c.

Materials. The general properties of materials. Elasticity. Weight. Specific weight. Mechanical work. Work done by pressure, by impact, by expansion of elastic gases and steam, by animal muscular

effort.

Resistance to expansion, to compression, to rupture. Friction of Its importance in construction. Resistance of fluids to bodies moving within them. Adaptation of form and material for maximum resistance. Beams of greatest strength. Construction of roofs, arches, stone and timber bridges, suspension bridges, and tubular girders.

Hydrostatics, Hydrodynamics, and Pneumatics. Pressure on floodgates; locks; water-wheels; turbines; water-pressure engines; breakwaters. Hydrometers. The syphon. Hydraulic ram. Pumps. Diving bell. Condenser. Windmills. Steam-engines, stationary, marine, locomotive. The steam hammer. Water supply to towns.

Theory of tides, in the open sea, and in rivers.

In this subject the candidate will be expected to show how the principles are applied in actual practice: he will be expected to show by clear well-drawn sketches, his acquaintance with parts of machines.

The candidate will have tools and models put before him, with some of which he must show he is familiar, and that he can explain their use and construction.

Books recommended:—Willis's Mechanism; Baker's Elements of Mechanism; the books in Weale's Series which treat on the subjects specified. Twisden's Practical Mechanics; Goodeve's Elements of Mechanism.

Subject VIII .- Acoustics, Light, and Heat.

Acoustics.

The candidate ought to know the manner in which sound originates, and is propagated; its velocity in different media, and how its velocity

through air is affected by density and temperature.

He ought to know the origin of musical sounds; of pitch; of harmony and discord; to commit to memory the rates of vibration of the several notes of the gamut; to be able to make sonorous vibrations visible by means of glass plates and membranes; to calculate the length of sonorous waves, and to determine practically the number of vibrations due to any particular note. He ought therefore to understand the construction and use of the Syren.

He ought to be able to describe and illustrate the condition of a vibrating string, or column of air at its nodal points and ventral segments and

to explain echos and resonance.

Light.

The candidate ought to know how its velocity was first determined from

observations upon Jupiter's satellites.

He ought to be able to devise a simple means of exhibiting both the reflection and refraction of light; to be able to state the laws of both; to explain what is meant by total reflection; and to apply it to the explanation of the Mirage of the Desert, the Phantom Ship, and other similar phenomena.

He ought to be able to explain why the image in a plane mirror must appear as far behind the mirror as the object is in front of it; why a stick appears bent when dipped obliquely into water; and why the bottom of a river or lake, or of a basin which holds water, appears to

be nearer to the surface than it really is.

He ought to be able to determine the positions of the foci of spherical mirrors, both concave and convex; to describe the characters of their images, whether erect or inverted; magnified or reduced; and to do the same for convergent and divergent lenses.

He ought to know the construction of the human eye; the conditions of distinct vision, the use of spectacles; and to be able to describe a simple form of the reflecting and refracting telescope and of the

microscope.

He ought to know the constitution of light; to be able to describe the spectrum produced by refraction with a prism; to explain the origin of colours, and to give a clear explanation of the rainbow.

Heat.

The candidate ought to be able to describe the construction and graduation of an ordinary mercurial thermometer; to understand the scales of Fahrenheit, Celsius, and Reaumur.

He ought to have clear ideas of conduction and radiation; to be able to devise some simple means whereby the conductive and radiative powers of different bodies may be determined; to explain fully the formation of dew, and to state the conditions favourable to its production.

He ought to know the effect of heat upon the volumes of bodies; to know what is meant by the coefficient of expansion, and how it may be determined; to give illustrations of the enormous power of heat in producing expansion; to state exceptional cases; to know the manner in which heat is propagated through liquids and gases, as distinguished from ordinary conduction; and to be able to combine two metals possessing different coefficients of expansion, so as to form a compensating pendulum.

He ought to know the meaning of latent heat and of specific heat, and to illustrate both by reference to ice, water, and steam; he ought to be able to show the influence of the high specific heat of water upon

an island climate.

He ought to know the strict physical meaning of ebullition; and the influence of pressure upon the boiling points of liquids; he ought to have a general knowledge of the origin of winds and clouds, and to be able to explain the fact that the rain-fall upon the south-west side of a mountain chain in England and Ireland is much more copious than on the north-east side.

Text Books:—See next subject.

Subject IX.-Magnetism and Electricity.

Magnetism.

The candidate ought to know the action of one loadstone upon another which is freely suspended, or set afloat upon a liquid; he must have a perfectly clear notion of magnetic polarity, and of the action of magnetic poles upon each other.

He must know the difference between the action of magnetised and unmagnetised steel upon a magnetic needle; also the difference between soft iron and hard steel, with regard to their acceptance and retention of the magnetic condition; (coercive force).

He must be able clearly to state the condition of a mass of soft iron when under the influence of a magnet, and in virtue of which condition the iron is attracted; (magnetic induction).

He must be able to describe the action of the earth upon a magnetic needle; must know the meaning of declination, inclination or dip, and of secular and diurnal variation; the action of the earth upon a bar of soft iron according as it is held in the direction of the dip or at right angles to this direction; finally, the effect of percussion in rendering the condition assumed by the bar of soft iron a permanent one.

Ye ought to be able to compare accurately the strength of one magnet with that of another, and to state how the relative intensity of the earth's magnetism at two points of its surface may be ascertained.

Frictional Electricity.

The candidate ought to know various simple ways of exciting electricity to be clearly informed as to the duplex character of the force; to know the condition of the rubber as well as that of the body rubbed; and to be conversant with various forms of electroscopes and electrometers.

He ought to know the foundation of the terms vitreous and resinous, positive and negative; to be able to illustrate the action of two electrified bodies upon each other; and to tell at once whether a body is positively or negatively charged.

He ought to have a clear knowledge of electric conduction, insulation, and induction; and be able to explain the state of a neutral conductor when acted upon by an electrified body; he ought to be able to prove, experimentally, that though we cannot by breaking a magnet obtain two halves each with a single pole, we can by breaking an electrified body obtain two halves each charged with a single electricity.

- He ought to be able to explain the influence of points and flames when attached to an electrified conductor; and to describe the action of lightning conductors.
- He ought to be able to describe the electric machine, and the electrophorus; and to explain the action of the condenser and of the Leyden jar.
- He ought to be able to state the principal effects of the electric discharge; to state the atmospheric conditions necessary to the production of a thunderstorm; and to give a clear account of the so-called return stroke.

Voltaic Electricity.

- The candidate ought to be able to state precisely how voltaic electricity may be generated; to describe Volta's pile, and his crown of cups; and also the batteries of Daniell, Grove, and Bunsen.
- He must have a clear conception of what is meant by the direction of an electric current; and be able to illustrate in the fullest manner the action of a current upon a freely suspended magnetic needle. Given the direction of the current, he must be able to state how the needle moves; given the movement of the needle, he must be able to infer from it the direction of the current.
- He must be able to describe fully the action of a current upon soft iron; and to infer from the direction of the current the nature and position of the magnetic poles, which it excites.
- He must be well acquainted with the chemical reactions which take place both in the batteries, mentioned above, and also in other liquids through which the current may be sent.
- He must be able to measure the strength of an electric current, and he is strongly recommended to master thoroughly the law of Ohm, regarding the mutual relations of electromotive force, resistance, and strength of current.
- He ought to be acquainted with the so-called polarisation of metallic plates between which a current passes through a liquid, and to show how this is avoided in Grove's battery.
- He ought to be able to give a clear description of some one form of the electric telegraph.
- He ought to be acquainted with the physiological effects, and with those of light and heat produced by the voltaic current; and to show the dependence of the heat on the strength of the current, and on the resistance which it encounters.
- It would also be well to master as much of the phenomena of induced currents as would enable the candidate to explain the action of the galvanizing apparatus used by medical men.
 - Note.—The candidate will perceive that this list is long because the objects to which he is to devote his attention are separately specified. Definition is thus given to his studies and their precise scope marked out for him. He is recommended to repeat with his own hands, as far as it is in his power to do so, the experiments which he finds described in good handbooks of Natural Philosophy; this will give a certainty to his knowledge and an interest to his pursuits which mere reading can never confer. The first requisite demanded of him on his examination will be that, however small his knowledge, it shall be well digested and sound.
- 'Text-Books:—Lardner's Handbook of Natural Philosophy; Natural Philosophy, by Dr. Golding Bird and Mr. Brooke.

Subject X.-Inorganic Chemistry.

The general principles of chemical philosophy. Laws of combination. Volume weights. Combining weights. Atoms and molecules. Chemical symbols and their use in the explanation of chemical changes. Quantivalence.

The non-metallic elements:

Hydrogen. Water. Chemical composition and properties. Adaptation for domestic purposes. Hardness, permanent and temporary.

Oxygen. Combustion.

Sulphur. Sulphuretted hydrogen. Sulphurous acid, sulphuric acid, hyposulphurous acid, hyposulphuric acid. Manufacture of oil of vitriol. Bisulphide of carbon.

Hydrochloric acid. Hypochlorous acid. Bleaching agents Chlorine. and theory of bleaching. Chloric acid and perchloric acid. Chloride of nitrogen. Chlorides of carbon.

Bromine. Hydrobromic acid and bromic acid.

Iodine. Hydriodic acid. Iodic acid, periodic acid.

Fluorine. Hydrofluoric acid.

Nitrogen. Ammonia. The oxides of nitrogen.

Phosphorus. Phosphoretted hydrogen. Hypophosphorous acid, phosphorous acid. The several modifications of phosphoric acid: ordinary phosphoric, pyrophosphoric, and metaphosphoric acids. Theory of polybasic acids. Chlorides of phosphorus. Manufacture of matches. Carbon. Marsh gas. Carbonic oxide. Carbonic acid. Olefiant gas.

Manufacture of coal gas. Nature of flame.

Silicium. Silicietted hydrogen and silicic acid. Hydrofluosilicic acid.

Boron and boracic acid.

The metals: Potassium. Manufacture of nitre. Manufacture of gunpowder. Theory of the action of gunpowder. Sodium. Manufacture of soda.

Rarium. Strontium. Calcium. Mortars.

Spectrum analysis; its principles and applications.

Magnesium, Aluminium. Manufacture of glass and porcelain.

Manganese. Iron. Composition and properties of cast iron, wrought iron, and steel.

Cobalt. Nickel. Chromium. Zinc. Cadmium. Copper. Lead. Manufacture of white lead.

Bismuth. Mercury. Tin. Arsenic. Course of analysis in cases of poisoning.

Antimony. Silver. Gold, and platinum. Principal compounds of the metals with the non-metallic elements.

Outline of qualitative analysis. Reactions of the principal mineral acids and bases. Course pursued in the application of these reactions to the analysis of a mixture of several acids and bases.

The following is a list of Apparatus and Re-agents which Candidates will find useful in analysis :-

Apparatus.

Test tubes and stand. Metal filter stand. Wash bottle containing: Pestle and mortar. distilled water. Spirit lamp. Black blowpipe. Charcoal for blowpipe experiments.

Iron spoon. Tongs. Porcelain dishes. Watch glasses. Porcelain crucible. Triangles. Test tube cleaner.

Platinum wire and foil. Funnels. Cut filters. Sulphuretted hydrogen apparatus. Platinum crucible. Herapath's blowpipe. Stirring rods.

RE-AGENTS. In the liquid state.

Sulphuric acid.
Hydrochloric acid.
Nitric acid.
Hydrosulphuric acid.
Potassa.
Ammonia.
Ammonium, chloride.
Ammonium, sulphide.
Ammonium, carbonate.
Ammonium, molybdate.

Ammonium, oxalate.
Sodium, phosphate.
Barium, chloride.
Calcium, chloride.
Lime water.
Calcium, sulphate.
Potassium, sulphate.
Magnesium, sulphate.
Potassium, chromate.
Oxalic acid.
Tartaric acid.
In the solid state.

Acetic acid.
Hydrofluosilicic acid.
Lead, acetate.
Iron, sesquichloride.
Potassium, ferrocyanide.
Potassium, sulphocyanide.
Platinum, chloride.
Silver, nitrate.

Sodium, carbonate. Potassium, nitrate. Potassium, cyanide.

Borax. Lime. Iron, sulphate. Blue and red litmus paper.

Subject XI.—Organic Chemistry.

Definition of organic bodies. Their ultimate analysis. Calculation of an empirical formula. Methods of controlling an empirical formula. Determination of the molecular weights of organic acids and bases. Determination of the vapour-density of volatile bodies. Law of substitution. Synthesis of organic compounds.

The chemical history of the Cyanogen group. Cyanogen. Hydrocyanic acid. Cyanic acid and urea. Fulminates. Cyanuric acid. Sulpho-

cyanic acid. Chlorides of cyanogen.

Amylaceous and saccharine substances. Fermentation. Alcohol, and its homologues. Ethers, simple and mixed. Oxidation of alcohol, Aldehyde and acetic acid, and their homologues. Chloride of acetyl. Anhydrides, simple and mixed. Compound ethers. Diatomic alcohols and their acids. Glycol and oxalic acid. Triatomic alcohols. Glycerine. Fatty and oily bodies.

Tartaric and citric acids. Tannic acid.

Aromatic bodies. Benzoic alcohol, aldehyde, and acid; their derivatives, their homologues. Salicylous and salicylic acid. Gallic and cinnamic acid. Hippuric acid.

Ammonia and its derivatives. Amides and amines: their classification.

Examples of natural alkaloids.

Principal colouring matters. Indigo and its derivatives. Examples of products formed by destructive distillation. Colours derived from coal tar. The chief constituents of the vegetable and animal organism, fibrin,

albumen, casein, &c.

The chemical principles of agriculture.

The chemical principles of the process of nutrition and respiration in

the animal organism.

Text-books. — Graham's Elements of Chemistry, Miller's Elements of Chemistry, Fownes' Manual of Chemistry, Bloxam's Chemistry, Inorganic and Organic, Galloway's First and Second Steps in Chemistry, Williamson's Chemistry for Students, Frankland's Lecture Notes, Roscoe's Lessons in Elementary Chemistry.

Subject XII.-Geology.

General Principles.

 The division of rocks into three great classes, aqueous, igneous, and metamorphic.

The mode of formation of stratified rocks, such as ordinary marine strata of shales, sandstones, conglomerates and limestones —delta formations — freshwater and terrestrial beds, and the signs by which you can distinguish these, such as the nature and mode of the occurrence of the genera of animals and plants that are found in them.

3. The theories of central heat, and of the consolidation of the earth

from a state of igneous fusion.

4. The mode of occurrence of igneous rocks, intrusive bosses, lavas, volcanic ashes, and dykes.

5. Volcanoes and volcanic phenomena; the origin of volcanoes and the

cause of eruptions.

Elevation and depression of land; the distribution and origin of mountain chains. Denudation of the earth's surface, origin of

valleys, &c.

7. The ordinary mineral substances that enter into the composition of rocks, such as granites, diorites, basalts, &c. Gneissic rocks, sandstones, slates, shales, clays, &c. The origin of limestones. The origin of mineral veins or lodes.

8. Fossilization of organic bodies.

9. Table of geological formations, including those larger divisions absent in Britain.

Theory of metamorphism of rocks. Origin of cleavage.

11. Explanation of geological terms.

12. Definition of zoological terms used in geology, such as genus, species, bivalve and univalve shells, cephalopod, brachiopod, palæozoic, &c. &c.

13. The meaning of breaks in the succession of life (changes of genera

and species) in the different formations.

Stratified Formations, &c.

1. Description of the Cambrian and Silurian strata, their physical characters, fossils, and any unconformities that exist in the British Silurian strata.

Description of the Old red sandstone and Devonian rocks, characters and fossils. Slate and slate quarries, building-stones, limestones,

and marbles of these and the Silurian formations.

3. The Carboniferous limestone and Coal-measure series. Character, fossils, and mode of formation. Nature of the plants of the Coal-measure epoch. Their mode of growth. Origin of coal, its mode of occurrence, and how the vegetable matter became changed into coal. Mode of occurrence of the ironstone of the Coal-measures. Various kinds of coal, and the relation of anthracite coal to disturbance of strata. Limestone quarries, marbles, and building-stones. Clay pits and potteries of the Carboniferous strata. Fire clay. Alum shale, &c.

4. The Permian rocks. Their stratigraphical relations to the underlying strata, composition of rocks, fossils, and building-stones. Great break in the succession of life between the Palæozoic and Mesozoic

or secondary strata.

The New red sandstone (or Trias), its subdivisions, fossils, buildingstones, sand pits. Origin of rock salt and brine springs.

The Rhetic beds and Lias, their subdivisions, fossils, building-stones and hydraulic limestones, and clay pits.

 Oolitic rocks. Subdivisions, leading marine and land fossils. Limestones, clay pits, coal, jet and other economic products.

8. The Purbeck and Wealden strata. Origin, subdivisions, chief fossils, building-stones, and marbles. Ironstones and limestones. Clays. Great break in the succession of marine fossils between the Oolitic and Cretaceous strata.

Cretaceous rocks. Subdivisions, lithological characters, fossils building stones of Lower Greensand. Gault, its phosphatic nodules and general uses. Upper greensand, chalk, &c. Building stones. Origin and uses of chalk-flints. Great break in the succession of marine fossils between cretaceous and eocene strata.

 Eocene, or older Tertiary beds. Subdivisions, alternation of marine and freshwater beds, chief fossils, limestones and building stones,

clays for bricks and potteries.

11. Miocene or middle tertiary strata, marine and freshwater, fossils, &c.

12. Crag. Its subdivisions, chief fossils. Origin of its phosphatic remains.

- The glacial period, boulderclay, and evidence of old glaciers in Britain,
 River gravels, &c. of post-tertiary age, and their contents.
- 14. Disturbance and denudation of strata in successive periods, &c.

15. Unconformities, faults, and fractures.

16. The causes of gaps in the succession of strata, or of breaks in the succession of life in time.

17. Water-bearing strata, and underground drainage. Artesian and other wells.

18. British rocks in which ores of metal are found, and the general mode of occurrence of these ores in beds of solid rock, in superficial detritus and in lodes.

19. The rules that ought to guide the miner in sinking for coal and other minerals, when the beds in which they lie are concealed by

over-lying and unconformable strata.

Text-books.—Lyell's Principles of Geology; Lyell's Elements of Geology; Phillips' Manual of Geology; Jukes' Manual of Geology; Juke's Geology for Schools; Page's Introductory Text-Book; Page's Advanced Text-Book; Ramsay's Physical Geology and Geography of Great Britain; Woodward's Recent and Fossil Genera of Shells.

Subject XIII.—Mineralogy.

A. Instruction in this subject should commence with a distinct understanding of the characters by which minerals, properly so called, are to be distinguished from other inorganic substances, and of the position of this science in relation to the collateral sciences of

physics, chemistry, and geology.

B. Crystallography, as the essential means of appreciating the forms naturally assumed by almost all inorganic bodies, must commence with the needful geometrical definitions, proceed to the grouping of the various crystalline forms into systems, consider the laws by which the derivation of one form from another within the limits of the same system is determined, and explain the combination of various simple forms in the faces exhibited by compound crystals. It is also important to study the deviations from regularity which are commonly presented in nature, and the methods of measuring those elements which remain constant.

c. The various kinds of aggregation exhibited by crystalline substances are also to be considered, especially with reference to masses of the

useful minerals, and of crystalline rocks.

p. Next in order will follow the other physical characters of minerals; 1st, in relation to their substance, as cleavage, fracture, hardness, and specific gravity: 2ndly, in relation to the effects of light, as transparency, refraction, lustre, and colour; 3rdly, as to their electric and magnetic properties.

E. The chemical characters of minerals, and the most convenient modes of testing them; lst, by aid of the blowpipe; 2ndly, by the

moist way.

P. Pseudomorphism, or the remarkable phenomena presented by minerals which have the composition of one mineral coupled with the form of another. G. The physiography or systematic description of minerals. This last division should include all the more remarkable varieties as well as species, and should take especial note of the modes and places of occurrence, as well as of the association of particular groups of minerals in certain veins or formations.

As text-books may be recommended—

Professor Ansted's Elementary Course of Mineralogy and Geology. London, 1856.

Nicol's Elements of Mineralogy. Edinburgh, 1858.

Dana's Manual of Mineralogy, 1851.

Bristow's Dictionary of Minerals. Longman & Co. 1861.

For more advanced students-

Brooke and Miller's Mineralogy. London, Longman, 1852. On Crystallography. Rev. W. Mitchell, in Orr's "Circle of the Sciences." London, 1856.

Dana's System of Mineralogy. 4th edition. Putnam, 1854.

Naumann's Mineralogie. Leipzig. Williams and Norgate, London.

Breithaupt's Paragenesis der Mineralien. Freiberg, 1849. Haidinger's Handbuch der Mineralogie. Vienna, 1845.

When it is intended to teach this subject with special reference to the practical working of minerals, the physiographical part will be occupied more particularly with certain of the useful species and their associated substances, and the following works may be consulted :-

W. J. Henwood on the Metalliferous Deposits of Cornwall and Devon,

1843.

Bischof, Chemical and Physical Geology, translated by the Cavendish Society. 1854.

Subject XIV.—Animal Physiology.

Candidates must be prepared to answer questions upon the following points in Human Anatomy and Physiology:-

The plan of the human body and the arrangement of its parts.

The meaning of the terms organ and tissue.

The general structure and disposition of the principal organs and tissues.

The ultimate chemical composition of air, water, carbonic acid, urea; of protein, fat, starch, and sugar; of bone-earth and horn.

The meaning of the term function.

The general working of the body considered as an engine; its waste, and the mode in which that waste is made good.

The particular functions of the different organs.

The structure and working of the heart and blood vessels.

The nature of the lymphatics and lacteals.

The course of the circulation of the blood, and the evidence that it circulates.

The pulse and the sounds of the heart.

The regulation of the circulation by the nervous system.

The structure and properties of blood corpuscles.

The process of the coagulation of the blood.

The proximate chemical constituents of the blood, and the uses of that fluid.

The difference between arterial and venous blood. The way in which that difference is brought about. The working of the chest and lungs in respiration.

The difference in chemical composition between inspired and expired air. The daily loss of carbon and gain of oxygen.

Stationary and tidal air.

The respiratory murmurs. The nature of asphyxia, and the

necessity for fresh air.

The structure and uses of the kidneys. The daily loss of nitrogen in the shape of urea, of uric acid and of saline matters, by the kidneys.

The structure and uses of the skin.

The relations of the lungs, skin, and kidneys.

The structure and uses of the liver. The nature of the bile.

The development, distribution, and regulation of the heat of the body.

The composition of aliments: proteids, fats, amyloids, and minerals.

Essential and accessory alimentary substances. Economy of a mixed diet.

The digestion and absorption of aliments.

Cilia and muscles; their structure and properties. The levers of the body. The structure of joints. Locomotion.

The structure and working of the larynx. Voice and speech.

The muscular sense. The organs of the higher senses, touch, taste, smell, hearing, and sight, and the manner in which they intermediate between the cause of the sensation and the expansion of the nerve. The adjustment of the eye to distances. The theory of the stereoscope.

Simple and compound sensations.

Auditory and ocular spectra. Auditory and optical delusions.

The general structure of the nervous system. The properties of nerves, and of the spinal cord, brain, and sympathethic. Vasomoter nerves.

Reflex actions, natural and acquired.

Text-books for Physiology.—Carpenter's Animal Physiology; Kirke's Manual; Huxley's Lessons in Elementary Physiology.

Subject XV .- Zoology.

1. Candidates should have carefully mastered the definitions of the sub-kingdoms, classes, and orders of the Animal Kingdom. They should understand and be able to explain the meaning of the terms employed in such definitions; and they should be able to refer any specimens that may be placed before them to their proper classes.

2. Candidates should be prepared to give fair answers to questions relating to any or all of the following subjects, and they should be able to identify, refer to their proper orders, and if called upon to do so, describe, the objects enumerated in each section under the head of "types." In almost all cases these "types" are British animals.

By the term Natural History, of such and such an object, is meant such an account of it as is to be found in any standard modern work on

Zoology.

The structure and mode of multiplication of infusorial animalcules and Foraminifera. The arguments which have been adduced
for and against spontaneous generation. The luminosity of the
sea, and the nature of the creatures which chiefly cause it. The
natural history of the sponge of commerce. Types—Spongia,

ii. The meaning of the terms, zoophyte, coral, coralline. Natural history of the red coral of commerce. Common coral and coral reefs. What such reefs are, where they are formed, and how they grow. Natural history of the common freshwater polype, or hydra, and of the "jelly fishes," or "medusæ" of the sea. A sexual multiplication as exhibited by these creatures. Types—Hydra, Sertularia, Plumularia, Actinia, Corallium, Fungia, Oculina.

iii. Starfishes, sea urchins, and Holothuriæ; their structure and habits, and the metamorphoses which they undergo. Natural and economical history of Trepang. Types—Uraster, Echinus.

iv. Natural history of the earthworm and the leech. Intestinal worms; their structure, propagation, and mode of entrance into animal bodies. Natural history of the Rotifera. Types—Lumbri-

cus, Hirudo, Distoma, Tania, Ascaris.

v. Natural history of Crustacea. The lobster and crayfish, as exemplifying morphological and teleological laws. The process of ecdysis. Barnacles, acorn shells, and fish lice, as cases of extreme metamorphosis. The water flea as exemplifying asexual multiplication. Types—Cancer, Homarus, Astacus, Oniscus, Daphnia, Cyclops, Lepas, Balanus, Argulus.

vi. Natural history of spiders, scorpions, and mites. The "itch insect," centipedes, and millipedes. Types—Tegenaria, Scorpio,

Scolopendra, Julus.

vii. Insects; their mode of breathing as contrasted with that of spiders and crustaceans. The structure of their wings, and the mechanism of flight. The parts of the mouth and their modifications in beetles, bees, butterflies, bugs, and gnats. Structure of the eyes. Nature of stings, saws, and ovipositors. Natural and economic history of the blistering beetle, of the silk moth, of the bee, of the cochineal insect. Natural history of plant lice, of bugs, fleas, and lice. The house fly, blow fly, and gnat; wasps, humble bee, ichneumon flies; "black beetles," crickets, and locusts. The metamorphoses of insects. Types—Melolontha, Blatta, Libellula, Phryganea, Coccus, Aphis, Bombyx, Apis, Vespa, Musca.

viii. The characteristic peculiarities of the nervous, circulatory, respiratory, and locomotive organs of mollusks in general. Organization of "sea mat" (Flustra). Ascidians and "lamp shells" (Terebratula). Natural history of fresh-water and marine mussels. Nature of mother of pearl. Formation of pearls. Pearl fishery. Natural and economical history of the oyster. Organization of snails and slugs, periwinkles, limpets, whelks. Development of the young of the latter. Nidamental capsules. Cuttlefishes and squids. Paper nautilus. Pearly nautilus. The shipworm and Pholas. Mechanism by which mollusks bore. Types—Flustra, Ascidia, Terebratula, Unio, Mytilus, Ostra, Pecten, Helix, Patella, Littorina, Buccinum, Chiton, Sepia, Loligo, Argonauta, Nautilus.

ix. Circulatory, respiratory, and reproductive organs of fishes. Their dentition. Natural and economical history of the lamprey, sprat, sardine, herring, pilchard, salmon, trout, eel, cod, haddock, sole, flounder, turbot, mackerel, tunny, sturgeon, skate, ray, dog fish, shark. Electrical fishes. Fishes which are capable of living in air. Pisciculture, or the artificial breeding of fishes. Types—Amphicaus, Petromyzon, Syngnathus, Cyprinus, Perca, Accipenser, Lepidosteus, Raia, Spinax.

x. Natural history of salamanders, newts, frogs, and toads, Metamorphoses undergone by their young. Types—Salamandra,

Triton, Rana.

xi. Circulatory and respiratory organs of reptiles as distinguished from those of fishes and amphibia. Natural history of snakes, lizards, crocodiles, turtles, and tortoises. Tortoise-shell. Shedding of the skin in reptiles. Types—Coluber, Pelias, Anguis, Lacerta, Crocodilus, Testudo, Chelone.

xii. Organs of locomotion, respiration, voice, circulation, and reproduction of birds. Structure and mode of growth of feathers, Development of the fowl's egg. Artificial hatching. Migration, and instincts of birds. Natural history of domestic birds; of the ostrich, the apteryx, the penguin, and the dodo. Types-Falco,

Corvus, Columba, Picus, Phasianus, Ardea, Struthio, Anser.

xiii. Organs of respiration, circulation, and reproduction of mammals. Production and nutrition of their young. Placental and implacental mammals. Nature of milk and of the lacteal glands. Peculiarities in the dentition of mammals. Natural and economic history of the domestic mammals; of the ivory and fur yielding mammals; of seals; of whales. The hybernation and migration of mammals. Characters of the orders of mammals. Types—Cercopithecus, Vespertilio, Erinaceus, Lepus, Elephas, Sus, Cervus, Bos, Ovis, Felis, Phoca, Phocana, Dasypus, Halmaturus, Ornithorhynchus.

xiv. The distinctive peculiarities of man. The characters of the principal races of mankind, and their geographical distribution.

Text-books for Zoology. - Dallas's Natural History of Animals in Orr's Circle of the Sciences; Gosse's Manual of Marine Zoology; Professor Greene's Manual of the Protozoa; Rymer Jones's Animal Kingdom.

Subject XVI.--Vegetable Physiology and Economic Rotany.

In this department the candidate will be expected to answer correctly

questions on the following points:-

1. The properties of the principal elements entering into the composition Carbon, oxygen, hydrogen, nitrogen, sulphur, phosof plants. phorus, chlorine, iodine, silicon, potassium, sodium, calcium, iron.

2. The composition and properties of the compounds forming the principal part of the structure of plants. Cellulose, starch, dextrine, sugar, fixed oil, gluten, albumen, caseine. The saline compounds forming the ashes of plants.

3. The composition and properties of peculiar vegetable products. Volatile oils. Acids. Colouring matters. Alkaloids. Neutral principles.

Chlorophyll.

4. The origin and growth of the vegetable cell. The tissues of plants Cellular tissue. Intercellular organs. Epidermal tissue.

Stomates. Vascular tissue. Woody tissue.

- 5. The structure and functions of the organs of plants. The root. Spongioles. Absorption and excretion. Nature of vegetable food. The stem. Structure of Exogenous, Endogenous, and Acrogenous The leaf. The forms of leaves. Exhalation Stipules and The flower. Calycine, Corollal, Staminal, and Carpellary bracts. Development and nature of pollen. Ovules or seed buds. Vegetable impregnation. Embryo. Seed. Fruits; their nature and forms. The nature of the reproductive organs in flowerless plants.
- 6. The composition and nature of vegetable substances used by man Distinctions between heat-giving and flesh-forming foods. Structure and geographical distribution of plants yielding starch, sugar, oil, gluten, albumen, and legumin.
- 7. Properties of vegetable substances used in the arts and manufactures. Vegetable secretions used as dyes.—Indigo, madder, logwood, red sanders wood, quercitron, alkanet, arnotto, gall-nuts, myrobolans.
- 8. Materials used in the manufacture of textile fabrics.—Cotton, flax, hemp, coco-nut, jute, New Zealand flax.
- 9. Principal forms of timber trees, and their uses.—Oak, mahogany, teak, pine, &c.

10. Nature of tanning principles and plants yielding tannic acid.—Oakbark, valonia, catechu, kino, divi-divi, betel-nut.

11. Gums, oils, and resins used in arts.—Gum arabic, benzoin, rosin, turpentine, camphor, essential oils, coco-nut oil, palm oil, other

fixed oils, caoutchouc, gutta pertsha.

12. Substances obtained from the vegetable kingdom and used as medicines.—Opium, quinine, tobacco, jalap, scammony, gentian, aloes, rhubarb, senna, ipecacuanha, sarsaparilla, castor-oil, assafœtida, myrrh, nux vomica, hemlock.

Text-books for Vegetable Physiology and Economic Botany.—Henfrey's Elementary Course of Botany; Van Voorst. Carpenter's Vegetable Physiology, edited by Dr. Lankester; Bohn. Schleiden's Principles of Scientific Botany; Bohn. A Manual of Structural Botany by M. C. Cooke. Archer's Popular Economic Botany; Reeve and Co. Lindley's Medical and Œconomical Botany; Bradbury and Evans.

Subject XVII.—Systematic Botany.

In this department the candidate will be expected to demonstrate the structure of plants from living specimens.

1. The distinctions between the three great classes of plants, Dicotyledons, Monocotyledons, and Acotyledons. Also of the groups Gymnosperms, Rhizanths, Dictyogens, Acrogens, and Thallogens.

2. The characters of the following orders of British plants should be mastered, and the typical genera recognized, and their structure

understood.

3. Algæ. The natural history and uses of sea-weeds. The microscopic structure of diatoms and desmids. Nature of the reproductive organs in this order. Types-Navicula, Desmidium, Conferva, Fucus, Ceramium.

4. Lichens. The natural history and uses of lichens. Structure of their

reproductive organs. Types-Graphis, Collema, Parmelia.

5. Fungi. The natural history of mushrooms, puff-balls, moulds, blights, and toadstools. Their uses in nature. Types-Agaricus, Bovista, Torula, Aspergillus, Morchella, Mucor.

6. Mosses. The nature of their reproductive organs. Types — Bryum, Sphagnum, Funaria.

7. Ferns. Nature of their rhizomes. Herbaceous and tree ferns. History of Development, and nature of reproductive organs. Types

-Polypodium, Hymenophyllum, Osmunda.

8. Graminaceæ. The history of grasses and their uses. Nature of the flower in this order. Useful plants of the order. Types-Phleum, Hydrochloa, Panicum, Agrostis, Arundo, Spartina, Avena, Festuca, Hordeum, Triticum, Secale, Nardus, Anatherum.

9. Cyperaceæ. Sedges. Types—Carex, Scirpus. 10. Liliaceæ. The lily tribe, its useful properties. Types—Tulipa. Ornithogalum, Muscari.

11. Amaryllidaceæ. The family of the narcissus, snow-drop, snow-flake.

Types—Narcissus, Galanthus.

12. Orchidaceæ. The orchis family. Structure of reproductive organs.

Types—Orchis, Goodyera, Malaxis, Cypripedium.

13. Amentaceæ. The family of the hazel, chestnut, oak, willow, birch, beech, poplar, and hornbeam. The uses of these plants as timber. &c. Types—Quercus, Corylus, Fagus, Castanea, Betula, Myrica, Salix, Populus.

14. Urticaceæ. The nettle and hop tribe. Its relations to Moraceæ. Artocarpacæ, Cannabinaceæ, and Ulmaceæ. The nature of the stings of Urtica, and the bitter principle of the hop. Types-Urtica.

Parietaria, Humulus.

15. Euphorbiaceæ. The spurge family. Foreign forms and their uses. Croton, Cascarilla, Ricinus, Janipha. Apetalous and Polypetalous forms. Types—Euphorbia, Buxus,

16. Polygonacee. The buckwheat and rhubarb tribe. Types—Polygonum, Rumex.

Primulaceæ. The primrose family. Theory of the peculiar position of stamens. Types—Primula, Lysimachia.
 Labiatæ. The dead nettle tribe. Peculiar properties of this order.

Types-Mentha, Salvia, Thymus, Nepeta, Lamium, Teucrium.

19. Scrophulariaceæ. The scrophularia tribe. Nature of the poisonous properties of the order. Types—Scrophularia, Digitalis, Verbascum, Euphrasia, Veronica, Melampyrum.

20. Boraginaceæ. The borage tribe. Peculiarities of their epidermis.

Useful species. Types—Cynoglossum, Borago, Echium, Myosotis

Lithospermum.

21. Solanacea. The tribe of deadly nightshade, henbane, tobacco, and potato. Useful and poisonous species. Types—Solanum, Atropa, Hyoscyamus, Datura.

The heath tribe. Its distinction from Epacridacea. 22. Ericaceæ.

Types—Erica, Arbutus, Vaccinium, Pyrola, Monotropa.

23. Composite. The composite family. The number of species and geographical distribution. Structure of the sub-orders Asteracea. Cichoraceæ, and Cynaraceæ. Types—Tussilago, Aster, Inula, Gna-phalium, Bellis, Artemisia, Achillea, Carlina, Carduus, Cichorium, Leontodon, Lactuca, Crepis.

24. Stellatæ. The Stellate tribe. Its relation to Cinchonaceæ and Caprifoliaceæ. The properties and useful plants of Cinchonaceæ. Types—Galium, Rubia.

 Umbelliferæ. Umbel bearing plants. Character of inflorescence and flowers. Nature of fruit. Structure of cremocarp. Properties of the order. Types-Hydrocotyle, Sanicula, Eryngium, Apium, Sium, Æthusa, Enanthe, Crithmum, Angelica, Pastinaca, Daucus. Torilis, Scandix, Conium, Coriandrum.

26. Cucurbitaceæ. Melon, cucumber, and gourd family. Useful plants of this order. Type—Bryonia.

27. Rosaceæ. The rose, apple, cherry, and plum tribe. Forms of the fruit. The useful plants of this order. Types-Prunus, Spiræa. Fragaria, Rubus, Geum, Rosa, Cratægus, Pyrus.

28. Leguminosæ. The bean, pea, and clover family. Principal divisions of the family. Structure of the flowers and fruits. Useful plants of the order. Types—Ulex, Trifolium, Vicia, Astragalus, Ornithopus.

Cabbage, turnip, and mustard tribe. Structure of the 29. Cruciferæ. flowers and fruits. Useful plants of the order. Properties. Types-Nasturtium, Alliaria, Brassica, Sinapis, Armoracia, Iberis, Isatis, Crambe, Cakile,

30. Papaveraceæ. The poppy tribe. Properties and mode of collecting opium. Nature of fruit. Types-Papaver, Glaucium, Chelidonium.

31. Ranunculaceæ. The crow-foot tribe. Structure of abnormal genera; Aconitum, Aquilegia, and Delphinium. Nature of poison in order. Types-Ranunculus, Clematis, Helleborus, Paonia, Anemone.

Text-books for Systematic Botany.—Lindley's Vegetable Kingdom. For British Botany.—Bentham's Handbook of the British Flora, or Babington's Manual of British Botany.

Subject XVIII.—Mining.

The Art of Mining embraces so wide a field of study that equal practical proficiency in its various branches is not to be expected; but those who wish to gain a general knowledge of it may be recommended to direct their attention to the subjoined heads, viz. :

1. Geology and Mineralogy, more particularly those portions of the sciences which bear on the following subjects,—the nature and position

in the earth's crust of the useful minerals, the classes of rock with which they are severally associated, the special character of heaves, throws, troubles, and all kinds of dislocation; the particular differences between beds and lodes, and their minerals, and the chief features of irregular repositories.

2. The methods of prospecting and searching at surface for ores and

other minerals.

3. Breaking of ground; the various implements employed, their form, dimensions, and weight; boring for shots; the various modes of firing charges. Heavy charges, how calculated and fired; rules for ensuring safety.

4. Deep boring, under what circumstances applicable,—apparatus for;

description of varieties in use; lining of bore-holes.

- Management and supervision; payment of men employed at mines, at surface and underground, varying in principle with the different classes of operation; reasons for tut-work or piece-work, and tribute or bing-tale under different circumstances. Calculations for cost of driving, sinking, tramming, &c.
- 6. Physical principles of ventilation; practice of mines where simple natural ventilation is employed; ventilation of large areas and of deep or complicated workings by guiding the natural current; artificial means, and their details, for promoting ventilation. Precautions to be taken under specially dangerous conditions.

7. Illumination of various kinds, their economy; safety lamps in all their best modifications; circumstances under which they should be

employed; precautions in their use.

8. Mechanical division of the subject. Strength of materials used in mines; human and horse power, principles and construction of machines to which they are applied. Hydraulic machines: construction of the water-wheels, turbines, and pressure engines most suitable to the various operations of mining. Steam engines, for pumping and for winding; arrangement and construction of the varieties most in use. Form and dimensions of boilers. Pumps employed in mines, mode of placing them; construction of the lifts; materials and details of the rods, setoffs, counterbalances, cisterns, and catches. Circumstances under which dams are erected in shafts or levels; mode of building them.

Tubbing of water from shafts; conditions under which it may be done; details of the operation with various materials, wood, brick, stone, cast and wrought iron.

Rails, waggons, and tubs for underground conveyance; employment

of horses and of fixed steam engines for this purpose.

Raising of the mineral through the shafts; various methods in use; chains, ropes (of hemp or wire), their weight, &c. Details of the best application of drums, cages, guides, keeps, and safety doors. Pulleys and shaft frames or poppet heads; protection against over-winding; safety clutches, &c. in case of breakage of rope.

- 9. Opening of ground; quarries and open work; driving of levels, various dimensions and directions according to circumstances; sinking of shafts, inclined or perpendicular; advantages of either kind under certain conditions; means of securing levels and shafts by timber or by walling; details of the various methods. Driving or sinking in heavy or running ground.
- 10. Working excavations; plan of laying them out, and means of security to be adopted whilst they are kept open. This will include the stoping of metalliferous veins, and the various modifications of post and stall, long-work, &c., which are applied to stratified deposits.

- 11. Travelling in shafts; prevention of accidents by proper fitting and dividing; mode of placing ladders and sollars; lifting machine for men, construction and advantages of.
- 12. Dressing of minerals. Arrangement of dressing floors. Construction of crusher and stamps; washing of coal; jigging, concentration, and separation of metallic minerals.

The student may be advised among other sources of information to consult the following works:—

De la Beche's Report on Cornwall and Devon. Greenwell's Treatise on Mine-Engineering. Dunn on the Winning and Working of Collieries. Hedley on Colliery Working and Ventilation. Smyth's Rudimentary Coal and Coal Mining. Evidence before Committees of the Houses of Lords and Commons on Accidents in Mines. Reports of H.M. Inspectors of Coal Mines. Transactions of the Northern Institute of Mining Engineers.

Subject XIX.-Metallurgy.

I. Introduction.

On certain physical properties of metals. Action of heat, specific gravity, crystallization, fracture, malleability, ductility, tenacity, conductivity of heat and electricity, opacity, lustre, colour. General considerations on metallurgical processes. Modes of occurrence of metals in nature, ores, reduction, smelting, roasting, liquation, slags.

II. Fuel.

General remarks, calorific power, calorific intensity, classification of fuels, wood, peat, lignite, coal, charcoal, coke, gaseous fuel and gas furnaces, charcoal burning, coke burning, typical varieties of coke ovens, comparison of fuels with respect to calorific power. This important branch of the subject is treated with much detail.

III. Refractory materials employed in the construction of furnaces, crucibles, &c.

Fire-clays British and foreign, crucibles of various kinds, plumbago and its application to crucibles, manufacture of crucibles, fire-bricks, silica and its applications, Dinas fire-bricks, sand and sandstones.

IV. Special Metallurgy.

Copper.—Compounds of special importance in the metallurgy of this metal fully described, such as the disulphide, oxides, &c., ores of copper, copper-smelting in reverberatory and blast furnaces, reactions occurring in the process, kernel-roasting, 'wet' methods, of extracting copper from its ores, assaying of copper ores by 'dry' and 'wet' methods,

ship sheathing.

Zinc.—In describing the metallurgy of zinc and the following metals, the same plan will be followed as in describing the metallurgy of copper, that is to say, the compounds of special metallurgical importance will be first considered in detail, as well as the reactions upon which the various processes of smelting essentially depend, and the construction of the furnaces will be fully explained. Ores of zinc, English, Belgian, Silesian, and Carinthian methods of extraction, assaying of zinc ores brass, its history, properties and manufacture.

. Lead,—Ores of lead, lead smelting in the 'ore-hearth,' low blast and reverberatory furnaces, lead-fume and various methods adopted for its

condensation, assaying of lead ores.

Silver.—Ores of silver; smelting of silver ores with lead; cupellation; desilverization of lead by Pattinson's process, also by that of Parkes;

treatment of argentiferous copper by liquation; extraction of silver; amalgamation, the old Freiberg method and the Mexican; Ziervogel and Augustin's 'wet' methods; treatment of argentiferous copper-regulus; alloys of silver and copper; standard silver; assaying of silver ores and

alloys.

Gold.—Modes of occurrence of gold in nature; extraction by amalgamation and by smelting with lead; chlorine-water as a solvent for the extraction of gold from certain ores; separation of gold from silver or parting by nitric and by sulphuric acids; alloys of gold with the preceding metals; standard alloys; assaying of auriferous ores and alloys.

Mercury.—Ores of mercury; extraction in the Almaden, Idrian, and Hähner furnaces; in retorts in admixture with reducing agents; assaying

of the ores of mercury.

Antimony.—Ores of antimony; liquation of the native sulphide and its subsequent reduction by iron or other agents; alloys of antimony, type metal, &c.; assaying of the ores of antimony.

Bismuth.—Mode of occurrence in nature; its extraction from ores

containing it by liquation; alloys of bismuth.

Nickel.—Ores of nickel; modes of extraction, generally by a combination of 'dry' and 'wet' processes; alloys of nickel, especially those known as German silver; assaying of nickeliferous ores and alloys.

Cobalt.—Ores of cobalt; smelting and preparation of zaffre and cobalt colours, smalts, &c.; separation of nickel; assaying of cobalt ores.

Arsenic .- Mode of occurrence in nature; arsenious acid or 'glass' of arsenic, generally obtained as a secondary product in the treatment of certain other ores, such as those of nickel, cobalt, &c.; modes of condensation of arsenical fumes; preparations of arsenical 'glass,'

Tin.—Ores of tin; smelting in reverberatory and blast furnaces; tin refining; varieties of tin in commerce; alloys of tin, with the preceding

metals, bronze, gun-metal, bell-metal, &c.; assaying of tin-ores.

Iron.—Malleable iron; steel; pig-iron; ores of iron, direct extraction of iron in the malleable state from the ore; smelting of iron in the modern-blast furnace; construction of blast-furnaces and blowing machines; economic application of the waste gases; conversion of pig into bar iron in open hearths and in the reverberatory furnace; manufacture of steel by various methods. This department of the subject will be treated at considerable length.

Various Metals.—Platinum and its associated metals; cadmium;

sodium; aluminium; tungsten; titanium; manganese.

Subject XX .- Navigation.

1. Elementary Principles.—Problems relating to latitude, longitude, differences of latitude, and differences of longitude.

Relation between an arc of a parallel of latitude and an arc of the equator. Principles of plane sailing and middle latitude sailing. Principles of Mercator's sailing. Mercator's chart. Principles of

great circle sailing. The compass and its corrections.

(1.) Variation. (2.) Deviation. (3.) Local attraction. (2.) Deviation. (3.) Local attraction. (4.) General theory of deviation (Towson's Practical Information, first 50 articles). Correction of courses for variation, deviation, and leeway. The log. Correction of estimated distances run for errors in the log line and glass. Plane sailing. Traverse sailing. Middle latitude sailing. Mercator's sailing, with examples.

To find difference of longitude made on a traverse. Sea journal. A day's work. Practice of great circle sailing. Circular arc sailing. Winds. Cyclones. To find bearing of a circular storm; veering of wind; heaving to; and sailing from centre of gale.

Construction of tables of meridional parts.

Description and use of sextant, with the theory, adjustments, and errors.

For students.—To obtain a 5th class, as far as principles of plane sailing. The compass and correction of courses.

To obtain a 4th.—As far as Mercator's sailing, with examples.

For third, second, and first class Queen's prizes, a proportionate knowledge of the remainder.

Subject XXI.—Nautical Astronomy.

Definitions. Time, apparent, mean, sidereal, &c. Equation of time. To express interval of mean or sidereal time in parts of sidereal or mean time respectively. To convert arc into time, and conversely. To find Greenwich date. To take out right ascension of sun for a given mean Greenwich date.

Correction of altitudes. Dip. Parallax. Refraction. Augmentation of moon's semi-diameter. Reduction of altitude of a heavenly body observed at one place to what it would have been if observed

at another. The chronometer and its use, error, and rate.

Latitude by meridian altitude of sun, and fixed star.

Latitude by meridian altitude of moon. To find Greenwich mean time of moon's meridian passage. To find semidiameter and horizontal parallax of moon for a given Greenwich date. To take out from

Nautical Almanac moon's declination, &c.

To find local and Greenwich mean time of passage of a star over a given meridian on a given day. Latitude by altitude of sun, star, or moon below the pole and by pole star. Latitude by altitude of sun or other heavenly body near the meridian. Calculations of hour angles. Meridian distances. Right ascensions. Computations of time. Error and rate of chronometer. Computations of time are at any place from observed altitude of a heavenly body. Longitude by chronometer. Error in hour angle from error in observed altitude. Variation of compass. Azimuth, altitudes, amplitudes, determination of true bearings. True azimuth from altitude of heavenly body and without observed altitude. True bearing of a point of land, &c., by observed amplitude of sun. Deviation of compass from observed amplitude of sun.

mation. Sumner's method of finding longitude and latitude.

Method of double altitudes, Ivory's and direct. Error of chronometer by equal altitudes of sun and fixed star. To compute apparent

altitude of a heavenly body when its true altitude is given.

Methods of clearing a lunar distance from the effects of parallax and refraction. To find Greenwich date corresponding to a given true lunar distance, &c. To find the altitudes when a lunar distance is taken from altitudes before and after taking the distance. To find the longitude by a lunar. Rate of chronometer by a lunar.

Obs.—In all the above problems the demonstration of the rules as well as accurate practical working is required.

For students.—To obtain a 5th class, a knowledge of the elementary principles, and finding latitude by meridian altitudes of a heavenly body.

To obtain a 4th, the above, with variation of compass from altitudes and azimuths, and rate of chronometer, and longitude by chronometer, is required.

For third, second, and first class Queen's prizes, a more or less accurate

knowledge of the remainder.

Subject XXII.—Steam.

- 1. General Properties of Steam.—General effects of heat and cold, with practical applications of the principle. Law of expansion by heat not universal. Beneficial result of this anomaly. To ascertain the temperature of any substance. Pyrometer. Thermometer-Description—Graduation. Comparison of thermometers when differently graduated. Laws of cooling. Conduction. Conducting powers of bodies. Convection. Explanation of some natural phenomena by this law. Radiation. Radiating power of bodies. On what it depends. Land and sea breezes. Capacity for heat. Unit of caloric. Latent heat. Under what circumstances heat becomes latent. Heat sole agent in melting and vaporising bodies. Calorimeter. Sources of heat. Combustion. Temperature necessary for it. Boiling point. Temperature of elastic fluids. Vapour. Formation of dew. Distinction between vapour and steam. Boiling points of fresh and salt water. Distillation. High-pressure steam. Measure of steam by atmospheres. Steam when in contact and when not in contact with boiling water. Relation between pressure, density, and temperature of steam. Specific gravity of steam. Common, superheated and surcharged steam. Priming. Analysis of sea water.
- 2. Steam Engine. General principles. Different kinds. Engines in use before Watt. Newcomen's engine. Its defects. Discoveries of Watt. Blowing through. Defects in atmospheric engines. Single acting and double acting engines. Expansion valve. Cornish-High-pressure or non-condensing engine. Marine steam engine. Different descriptions. Side-lever marine engine. Blow-valve. Stuffing boxes. Piston of steam cylinder. Working parts. Working of the slides, strap, gib, and cutter. Escape valve of cylinder. Parallel motion. Hall's condensers. Test cocks. Grease cocks. Grease cups of slides. Annular air-pump bucket. delivery valve. Various kinds of slides. Cushioning. Lead. Lap, its effects. The eccentric. Throw and stops of ditto. To find the travel of the slide. Back-lash. Double eccentric. Throttle valve. Expansion valve and various kinds. Barometer or condenser Method of estimating pressure by it. Errors in this method, and correction of the same. Lubricators, &c. Number of engines in a steamer. Expansion cams and gear. Feed pumps. Bilge pumps. Modes of propulsion. Paddle wheels. Pitch, Reefing. Disconnexion and immersion of wheels. Brakes.—Modes of fitting. The screw propeller. Length, angle, pitch, slip, area of screw Disconnecting and raising screw. Governors. acting engines. Gorgon—Fairbairn's double cylinder, oscillating, trunk engines, &c. Engines for screw propellers. Direct acting, with and without multiplying gear. Oscillating horizontal and trunk engines. Double acting air-pump.
- Boilers.—Description. Gear connected with them. Tubular boiler. Number of boilers. Steam chest. Safety valve. Waste. Steam funnel and drip pipe to steam gauge. Wash or dash plates. The funnel dampers. Reverse valve. Communication or stop valve. Blow-out cocks. Circulating pipes. Brine pumps. Brine valves. Refrigerators.
- 4. Calculations.—Methods of measuring efficiency of steam engines.

 Duty of an engine. Horse power. Mercantile or nominal horse power. Horse power from the evaporation in the boiler. De Pambour's theory. Velocity of maximum useful effect. To find evaporation of a condensing engine of given dimensions and horse power, the piston moving with a given velocity with and without

expansion. To find the pressure in cylinder, knowing the effective evaporation. To find the diameter of a cylinder to work at a certain speed, knowing the evaporation. To find the evaporation in the boiler, knowing the diameter and velocity of piston and pressure of steam in the cylinder with and without expansion. Same for

locomotive, Watt's engines, &c.

The screw—to find its area. Angle of the helix or thread of the screw propeller—to find the pitch. The power exerted by a screw. How far slip depends on form and dimensions of the screw. Motion of paddle-wheels, &c. Consumption of fuel. Measure of locomotive performance of marine steam engines. To find the angle the crank has moved through when the piston is at a given distance from the top of the stroke. Amount of work developed by crank in a half-revolution—length of radius-bar in side lever engine. Work done in the up and down stroke of the air pump. The best temperature for the condenser of a steam engine. Qualities of fuel, &c.

- 5. Practical working.—Getting up steam. Mode of starting. Working engines at moorings. Priming—causes and remedies. Banking up and putting back fires, &c. Duties to machinery when under steam, boiler, fires, &c. Injection pipes. Kingston's valves. Leaks in engines. Bearings of engines. Expansive working. Management of fuel. Damages and repairs to boiler, &c., after accidents. Duties to engine, &c., on arriving in harbour.
- 6. Indicator.—The ends it fulfils. Description. Atmospheric line. Method of taking a diagram. The general configuration of diagram to be expected under various circumstances. The slide-diagram. Examination of Indicator-diagram when steam is throttled; when expansive gear alone used, and in other cases. To ascertain the horse-power of an engine by means of the indicator. To find quantity of water evaporated. Friction of steam engine without load. Diagram when there is no condensation. Diagram showing the relative motions of slide and piston at every point of the stroke.

Dynamometer. To find horse-power of engine by means of it.

The text books specially recommended are—The Marine Steam Engine, by Professor Main and Mr. Brown, R.N., Longmans and Co.; Main and Brown's Indicator and Dynamometer; De Pambour's Theory of the Steam Engine.

Subject XXIII.—Physical Geography.

The following very brief outline of the principal branches of this subject may be useful:—

- a. So much elementary astronomy as relates to the position of the earth in the solar system, its magnitude and rotation, and the influence of the sun and moon on terrestrial phenomena.
- b. So much of elementary physics and inorganic chemistry as includes the nature and mode of action of the physical forces and the composition of rocks.
- c. So much of elementary geology and mineralogy as includes a knowledge of the nature of rocks, their superposition, succession, and disturbances.
- d. So much of palæontology as includes a knowledge of the distribution of life in time.

- I. The distribution of land. Form of land, continental and insular. Elevation of land. Mountains. Plateaux or table-lands. Low plains. Valleys. Deltas. Grouping of islands.
- II. Phenomena of water. Oceans and inland seas. Composition and temperature of oceans. Movements of water. Tides and currents. Waves. Lakes. Rivers and river systems. Waterfalls. Circulation of water on the globe. Ice. Glaciers. Springs.
- III. Phenomena of the atmosphere; its nature and composition. Effects of heat on air. Winds. Periodic winds. Storms of various kinds. Electric storms. Magnetic storms. Effects of moisture in the air. Dew. Clouds and rain. Estimate of rain-fall. Climate and weather.
- IV. Volcanic and earthquake phenomena. Distribution of volcanoes. Volcanic groups. Nature of an eruption. Nature of earthquakes. Range of earthquakes. Statistics of earthquakes. Result of volcanic action and upheaval on the physical condition of the land.
- V. Distribution of vegetation on the globe in space, horizontal and vertical. Influence of climate and soil on natural groups of plants. Representative forms of plants. Range of cultivated plants.
- VI. Distribution of animals in space. Zones of height in the air and of depth in water. Corresponding forms of animal life in different zones or belts. Relation between parallels of latitude and zones of height or depth. Special distribution of certain classes and groups of animals.
- VII. Distribution of plants and animals in time.
- VIII. Ethnology. Families of the human race. Geographical limit of certain races. First introduction of the human family. Modification of the races of men. Influence of man on vegetation and on animals. Extinction of races by human influence. Influence of man on inorganic nature.
- The text-books recommended are—
 Ansted's Physical Geography (2nd edition); Johnston's smaller
 Physical Atlas; Maury's Physical Geography of the Sea (last edition).

LIST of SCIENCE SCHOOLS, giving the NUMBER of STUDENTS returned as under Instruction in MAY 1866 and MAY 1867, and the NUMBER of PRIZES and MEDALS obtained in MAY 1866 and MAY 1867.

LIST of SCIENCE SCHOOLS, giving the NUMBER of STUDENTS returned as under INSTRUCTION in MAY 1866 and MAY 1867, and the NUMBER of PRIZES and MEDALS obtained in MAY 1866 and MAY 1867.

Schools established since May 1866 are in Italics.

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Chairman,			Strange, W. A., D.D. Ingram, J. Consterdine, Rev.		Clarke, T. P.	Smith, H. E.	Mason, Hugh	Aitken, John .	Harrison, W. R.	•	Hamer, A. G	Martineau, T Winter, Rev. S. W.	Scoucraft, Rev. J. H. Smith, David .	222	Cope, C. R.
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Parkinson, Giles Hand, Thomas - Meikle, William Phillips, Josias	Marsden, Peter C. Vickers, James-	Lowe, Rev. J	Barton, J Cunnack, R. J.	Wilkson, J.	Gibson, C. IV.	Briggs, Benjamin	Graham, John - Massey, J Sutherland, J	Sutherland, J	Probert, T. W	Pike, Walter - Price, Peter -	Moore, H. J.	Harris, Rev. Jas.	Mercer, John, jun.	Miles, Rev. S Stubbs, Thomas	Price, G. N.	Swinburne, T Bradbury, A	Earland, Thos.	Marchant, T. W.
Beads, Jas. Hutchinson, R. H Fincham, W. C. Stokes, H. S	Cannon, W. W.	Powell, Rev. Henry	Gadon, John Pridmore, Rev. E. M.	Moselcy, Rev. Canon	Collis, F. D.	Parker, Rev. A. T	Ashworth, Thos Massey, Lord Shuttleworth, Sir	Shuttleworth, Sir	Hildyard, Rev. C. F.	Smith, George Davids, C. W	Downing, James -	Frost, Meadows -	Dewhurst, Robert	Stuart, Rev. A. G.	Carpenter, Dr	Pease, Henry - Graham, Rev. P.	Money, Rev. C. F. S.	Lewes, S. S
Wesleyan School Mechanics' Institution Working Men's Club Literary Institution	Bridge Street School Independent Methodists' School	Science and Art School	Mechanics' Institute Cornwall	Trade School	Literary and Mechanics'	Church of England Literary	Carlton Road School Westgate School Mechanics' Institution	Grammar School	Athenseum	British School Free Library	Bedford Buildings	Mechanics' Institution National School	Mechanics' Institution	National Schoolroom Mechanics' Institution	Literary Institution	Science Class - Mechanics' Institute	St. John's School	St Paul's School
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Blackburn - Blandjord - Bodmin -	Bolton		Breage	Bristol • •	Bromsgrove .	Burnley -		•	Bury .	Camborne Cardiff -	Cheltenham	Chorley	Clitheroe -	Cottesmore Crewe	Croydon -	Darwen .	Deptford -	•

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Teacher.		Hurst. W.	Greaves, C. A.	Spriggs, C }	(Pullen, M)	Forbes, D. M.	Jarmain, G.	(D'Urban, W.S.M.)	Shaw, H. C.	Gee, William:	Jeffery, Walter Cockman, A.	Sullivan, M }	Weatherill, R.	Shore, T. W.	Spriggs, C	Jarmain, George	Scaping, Zebedee	Richardson, H.	Pascoe, John	{Fallows, J. H.	Sturgess, Wm Parkhouse, Hy
Secretary.		Bailey, F	Longdon, F.	Blackburn, Jas.	Hooner C H	Warner, E.		•	٠,	Wood, Samuel -	Fowler, Hugh - Maddison, Rev. G.	Jordan, C. H.	Webster, T.	Gino, George Binns, John	Fairbrother, G.	Rhodes, Geo. W.	Wilson, Edward S.	Letch, Geo. V	Vessy, Rev. F. G.	Lawton, Thomas	Eldred, George Thomas, W. J.
Chairman,		Nicol, Rev. W.	Renals, J.	Ashworth, George -	Potore Row Whos .	Ford, G. Wright, F. B.	Farrar, J.	Head. R. T.	Carne, W.	Atkin, Thomas	Washbourn, B. Burbidge, J. F.	Purviss, Prior -	Chaloner, Thomas	Thompson, Rev. R.	Smith, Mark -	Smith, A. M. A.	Whitaker, Thomas -	Aspden, Richard .	Ward, W.	Hibbert, E.	Lindsay, Rev. H Davis, Rev. J. W
Where held.		Mechanics' Institution	I'ne Grammar School -	Educational Institution -	National School	Wesleyan Day School Mechanics' Institute	Mechanics' Institute .	Literary Society	National School	Mechanics' Institution.	Blue-coat School Science Class	Literary Institution -	Mechanics' Institution	The Institute	Mechanics' Institution -	Mechanics Institution -	Nautical Schools -	Working Men's Institute	Walden's School	Mechanics' Institute -	National School
Town.		Denton	Thereof	Droyladen	Eastington -	Eastwood	Elland	Exeter	Falmouth	- dossoin	Gloucester Grantham	Greenwich .	Guisborough .	Haslingden -	Heywood	Huddersfield -	Hull	Hulme : :	Huntingdon -	Hyde	Kingsbridge
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- List of Science Schools and Classes, &c. - continued.

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Packer, M. W. Prosser, W. Vard, George Atkins, Edward Poyner, H. Crawley, Samuel Crawley, Samuel	Birkenhead, B. F. Adair, S Jones, John	Davidson, E. A. S. Martin, J.	Pike, Robert W. Simpson, B. Eastburne, Rev.C.	F. Dawe, C. S. Lawson, W. Atkins, G.	Snelus, G. J. Howard, J.	Bithell, B.	Duckett, W.	Gibsone, Rev. B.	Coles, F.	Coles, F.	Newton, John -	Tate, R.	Holl, Joseph	Schoffeld, J.	Angell, J. Mellor, J. Tomkins, E.
Bolton, Thomas Moore, J. B. Sales, H. H. Jones, H. S. Pertuce, Rev. A. Nelson, Rev. H. Blenkin, Rev. F.B.	Gregson, S. L Sharpe, Charles Davies, John	Wormell, Rich. Bryant, W. J. D.	Rüntz, George - Halliday, J.	Benham, Rev. W.	Rawlins, Hy. E. Ross, John	Hoskins, W. H.	Heller, T. E.	Maskell, Rev. J.	Cousens, J.	Parry, H	Webb, W. H.	Hutchison, T.	Gregory, John -	Ellis, R. P.	Jarrett, Albert -
Wharton, Rev. G. Turner, Rev. Canon Hole, James Vaughan, Rev. D. J. Jones, Rev. T. Anhey, W. Keyworth, J. R. H.	Samuell, E. S. Samuell, C. S. Nevill, C. W.	Jenkinson, Rev. J. S.	Rogers, Rev. W	Mayo, Rev. M. W	Maurice, Rev. F. D Fleming, Rev. W	Aveling, Rev. T. W.	Scaton, Rev. W.	Whittington, Rev. R.	Mackenzie, Rev. C	Campbell, Hon. D	Maude, Francis,	Gray, R. A.	Wardle, Thomas - Lindsay, Rev. T	Callender, W. R.,	Jun. Neill, Robert
National Schoolroom Mechanics Institution Mechanics Institution St. Martin's School Grammar School Training College Hechanics Institution	Free Library - Liverpool Institute - Copper Works School -	Otty Middle-class School Str Watter St. John's School	Birkbeck Schools National School	St. Mark's Practising School		Kingsland and Dalston In-	Boys' Schoolroom, Lambeth	City of London College -	Royal Polytechnic Institution	London Mechanics' Institu-	Sailors' Home	Upper and Middle Schools	Modern Free School - Oldham Road National	School. Roby Educational Society's	Rooms. Mechanics' Institution
Kinver Lancastér Leeda Leicester Láncoh	Liverpool Liverpool Lianelly	London:— Bath Street Batterses	Bethnal Green	Chelses	Gt.OrmondStreet Islington	Kingsland	Lambeth -	Leadenhall St	Polytechnic -	Chancery Lane -	Dock Street	Peckham -	Macclesfield	Manchester	

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List of Science Schools and Classes, &c. -continued.

Town.	Where held.	Chairman.	Secretary.	Teacher.	Num Indiv	Number of Individuals under			Number of Prizes.		Number of Medals.
				Man Constitution	1866. 1867	1867.	ownI	Deer	1866, 1867.	7. 1866.	1367.
Manchester Middlesborongh -	Corporation Street - Church of England Institute	Smith, Rev. A. C	Plant, John - Donaldson, Rev.	Lightbown, J. H Stead, W.	3 :	8 o	:9	9 :	20 •	1 B.	::
Middlesborough - Middleton - Nelson-in-Marsden Newport (Mon.) -	PERM	Gilkes, Edgar	A.B. Taylor, Wm Ward, Bev. C. B. Waddington, J. Maynard, E	Weatherill, R	e488	esses.	:10 : :	1 :0 L	1222	:ల్ల్ : ;	: :: # ;
	Institution. Charch Street Mechanics Institution Church Institute	Taylor, Joshua Taylor, Joshua Pennyman, J. S.	Evans, George-Holt, Samuel	Lightbown, J. H. Jones, Thomas Weatherill. Robert	:91	527	ន្ទ::	-4-w	:00 04	:::	; : :
	Mochanics' Institution -	Morse, Rev. F.	Thurlow, Richard	Simpson, A	22	88	: 8	61 19	19 4		:::
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	Parish Church School Analytical Society National School	Schofield, James - Fox, Rev. J. H	Walters, Rev. W. Nuttall, William Warburton, Rev.	Mellor, James	: 13:	6148	18	:::		:::	:::
• • •	Free School Mechanics' Institution Pendleton Club	Gardner, W Waterhouse, J Armitage, B., Jan	Skinner, J. W Harrop, J.	Jones, Thomas Stater, J. K.	: 14	110	::8	2200	50 : 07	::.:	:::
, •	Burrage Road School	McAlister, J. A.	Hammond, J	Shipman, C S	22	8	ю	<u>.</u>	- 94	1 B.	.:
10.4	28, Buckwell Street -	Risk, Rev. J. E.	Widlake, T. H.	Hington A	:	18	18	· :	:	:	: :
• •	Science School	Radford, W.	Cawse, J. H. M.	Rickard, G. J	124	154	ຂ	<u> </u>	88	18.1B.	. 18., 1B.
	Navigation School Science School The Grove School School of Science Science Class National School	Hill, Richard	Cuming, W. B. Bassett, C. Hill, Rev. Arthur Dunn, James - Lufkin, Charles Corbould, Rev.	Merrifield, J. Robotham, W. Roffat, Fm. Birkenheed, B. H. Goffin, Robert- Wheeler, G. H.	:8 :88 :	283211:	::54%	:2:::	:1:77: 15988	::::::	· • • • • • • • • • • • • • • • • • • •

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Bournes, Thomas - Foster, C. Le Neve - Lightbown, J. H.	Almgill, T. Monks, P.	Tomkins, E. Dorrell, J.	Gee, W.	Vick, W.	Pullen, M.	, ,,	Packer, M. W. Birkenhead, E. H	7	Burgess, Rev. S. Stone, W. Davison W.	Jones, T. Duckett, W. Davidson, G. Jones, E. S. L. Brown, T.	(Noble, John - Rowden, W. T.	Busbridge, W.	Stockton, W.	Ripley, H Browne, J		Beveridge, Dr. Maver, D. Bitchie George	Jones, J. R. Macomish, M. Kennedy, John
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Menzies, W. J Boyns, R	Plant, John	Richardson, Chapman, J.	Robinson, S.	Holland, Rev. P.	Gardner, H. F.	Gurney, N. Weeks, C.	Irvine, Rev. A. C. Peace, M. W.	Langley, J. N.	Meadley, J.	Keeble, W. D	Wilson, James	Norman, J. H.	Cubitt, F. A.	Hall, Robt.	SCOTLAND	Sinclair, J.	Kellas, J. F. Hourston, S. Cumming, A.
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Mocatta, Rev. W. A. Hadow, Rev. G.	Pickup, Varey	Mather, John W. D. Cree, Rev. J. A.	Leigh, William	White, Rev. W. F.	Dickinson, S.	Moorhouse, Rev. J. Sheppard, A. B.	Harvey, John Jesson, R. Fercie, Rev. T. F.	Iles, Rev. J. H.	Mumford, A. L.	Anderson, John	Brown, Rev. H.	{Robertson, Capt.}	Nuil, H. B.	Palmer, Rav. H. V		Matthews, James	Cook, John - Sturrock, Bev. G. Sturrock, John
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St. Thomas's School - The Institution -	Working Men's College	St. John's Hall Mechanics Institution	Mechanics' Institution	The Institution •	Strond Institute .	Wesleyan Day School School of Science and Art	1, Spring Cottage Science School Mining and Mech School	Athenseum Class	Science and Art Institution	{ Mechanics' Institution, }	National School	St. Thomas' Parochial School	Navigation School	Popular Institution -		Mechanics' Institution	Navigation School - Girls' School - High School -
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List of Science Schools and Classes, &c. -- continued.

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Teacher.	•	Mayor, J. Mayor, Mrs. Mellas, J.	Rain, Rool, I. (Stevenson, Jame Dunn, H. S. Bolam, J.		Mills, L. G.	James, M. H.	McGiffin, Robt.	Shannon, A. F. Black, R Gillemie, Jas	Browns, W. M.	McNoill, James	Cleeland, Robt.	Browne, W. M. Smeeth, Rowland	MacHillan, W.	Messrs. Stevenson	Barklie, R. Millar, J. B.	Gray, T.
Secretary.	-	Cunliffe, Rich. S. Lang, Gilbert .	Galloway, G MacKay, John - Thomson, Rev. J.	RELAND.	Davidson, B. P.	Berry, Rev. E. F.	Smiley, Alexr. Lynch, Rev. J.	Given, John Lynch, Rev. John Noble, John	Shepherd, W.	Neebitt, R.	Shepherd, W	Shepherd, W	Shepherd, W.	Nesbitt, R.	Nesbitt, B.	
Chairman.		The Lord Provost . {	Dallas, W Attken, Rev. James Paton, Walter	7.7	Brown, S.	Handcock, R. Dalton, G. T.	Moore, Rev. S. J.	Kowan, Kev. K. W Rowan, Rev. R. W Anderson, Rev. R.	Mullan, W.	Lytle, John	Mullan, W.	Mullan, W	Mullan, W.	Lytle, John	Lytle, John	
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Where held.		Secular School	Andersonian University Science Class. New Public School Navigation School		(Natural History Society's)	St. Mary's Schools Model National School	Science Class National School :	Model School National School Scarva Street National Sch	Eginton Street National	Street	ace	Linen Hall Street Model School .	Stanhope Street Nation School	Great George Street	Crumlin Boad Old Lodge Road	Academy Street
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Wren, E	Mayne, A. J.	Stevenson, J. McNeill	Todd, J. J.	Watt, W. D.	Leetch, J.		(Smeeth, J. F)	Joyce, P. W.	O'Hara, H.	Lyons, M.	Kelly, D.	Magennis, P.	McIlvoy, H.	Moylan, J.	Speers, A.	Ryan, L. J.	C'Neill, Sami.	Doran, C.	Greer, Alex.	Greer, W. H.	Beatty, J.	MacMillan, B.	Cotter, E. G.	Mayne, A. J.	Freehill, M.	Sullivan, M }	-	•
Molloy, J. Orr, W. Nesbitt, B.	Kavamagh; Kov.	Nesbitt, B.	Moore, J. D.		Withers, Robt.		crey, L. J.	Butler, E.	Leech, T.	Frice, Ikev. New-	Dugan, C. W	Bagot, E.	Raphael, J., jun.	Gordon, J.	Shepherd, W	Porter, Rev. J	Eccies, wm.	Churci, Rev. C.	Roantiee, S.	Osborne, A. T	O'Neill, Bichard	Gilcriest, Rev. J.	Wilson, T.		Conwell, E. A.	Cavet, J.		
O'Callaghan, A. Montgomery, J. Alexander, N. B.	O'Neill, Rov. B.	Lytle, John	Iucas, E. W MacManus, Rev. P.	Rogers, J.	Sheridan, J. E.	Matthews, J.	· · · · · · · · · · · · · · · · · · ·	Sullenge, R -	Haughton, J	Neville, J.	Crawfield, T. G.	Robinson, A. H.	Young, John -	Persse, T. M	Patterson, R	Blunden, Sir J.	morgan, nev. I. F.	Crickard, Bev. J.	Moore Bor II	Pooler, Rev. J. G.	Durdin, Rev. J. G	Sherrington, T. A.	West The Very Dow	J.	Lightburne, H.	Hoare, Rev. E. N		
National-Model School Wolfnid Mill, Ligomiel Maritime Model School	Christian Brothers' Schools	Model School -	Science Class	No. 1 National School	District Model School	St. Mary's National School -	2	Contrat Model School -	Mechanics' Institution	Free Library	Model School -	National School	National School	Model School	Science School	District Natl. Model School	_ •	National School	arouse School	Model School	Endowed School	National School	C National Society's Training	School.	District Model School	Model School -		
Belfast Belfast Belfast Belfast	Carlow	Carrickfergus -	Custleshane	Comber	Cork	Drogheda		Duoma		Dundalk	Enniscorth,	Fintona	Galgorm	Galway	Holywood	Kilkenny		Loughinisland -	Turking .	Newtownsards -	Oldcastle	Portadown -	anuting	Santry	mr.	Waterford -		

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